Iowa (Iowa State University) Annual Report - FY2021

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Contributing Organizations

Iowa State University

Executive Summary

Overview

Agriculture in the state of Iowa has grown beyond traditional production of crops and livestock to encompass the bioeconomy, life sciences, food sciences, value-added products, environmental sciences, and social sciences. Iowa's world-class endowment of natural resources, our highly skilled and educated people, and our well-developed infrastructure support a diverse and dynamic set of food, feed, fiber, biofuels and bioproducts, environmental, and community endeavors.

Iowa's abundance is astonishing, ranking second nationally (behind California) with cash farm receipts (2020) of $28.36 billion. This position is the result of Iowa's strong ranking in the production of several commodities. In 2020, Iowa was the nation's largest producer of corn, pork, eggs, and ethanol; second in soybeans; fifth in cattle production; sixth in turkey production; and 11th in dairy. Iowa had 86,104 farms operating on 30,563,878 acres in 2017. Cropland accounts for 87 percent of Iowa's total farm acres (2017). The average farm size in Iowa is 355 acres, while the median farm size is 142 acres (2017).

Iowa had 3,193,079 residents in 2021, ranking 31st among states in total population size. The state's nine metropolitan statistical areas (MSAs) include 22 of its 99 counties and 61 percent of its total population (2020). Iowa's 39 percent non-metropolitan population share is 9th highest among states. Slightly more than one-third (36 percent) of Iowa residents live in a rural territory with fewer than 2,500 inhabitants, ranking 11th among states (2019).

The Hispanic/Latinx population, which includes people of any race, is the largest minority group in Iowa, accounting for 6.8 percent of the population in 2020. The Black or African American population, both Latinx and non-Latinx, is the second-largest minority group with 4.1 percent of residents. The Asian population is third with 2.4 percent (2020). Iowa's non-Latinx white alone population accounts for 82.7 percent of the total population (2020). The poverty rate for individuals in Iowa was 11.2 percent (+/- 0.5%) in 2019, compared to a rate of 12.3 percent (+/- 0.1%) in the United States. Minority students comprised 28.3 percent of PreK-12 public school enrollment in 2021-22, compared to 10.4 percent in 2001-2002.

Continuing demographic changes, globalization, and technological innovations create ongoing opportunities and challenges toward achieving socially beneficial, economically successful, and environmentally sound systems for food, feed, fiber, fuel, and other value-added products. To this end, we have identified six, long-term critical issues that our research projects and extension programs are designed to address:

- Food Production and Agricultural Systems
- Natural Resources and Environmental Stewardship
- Community and Economic Development
- Health, Nutrition, and Well-being
- Human Potential and Youth Development
- Transformative Technology

Research is conducted across most disciplines in agriculture, defined in its broadest sense, from foundational to applied, to make advances in production, to help increase capacity, and to provide an adequate and nutritious food supply. The research expressed in the program areas is the result of cooperation among researchers within and between departments and colleges at all levels of activity. Hatch and Smith- Lever capacity grants provide critical funding for sta?ing that ultimately allows us to leverage and match other external

funding sources. The capacity grants also provide flexibility in programming to better and more quickly meet current and emerging needs not being addressed by other sources of funding. Without these funds, there would be less applied research, less real world application of research, and less integration of extension and research work.

Critical Issue: Community and Economic Development

Over half of Iowa farmland is owned by someone who does not currently farm. Of that land, 34 percent is owned by owners with no farming experience and the remaining 24 percent is owned by retired farmers (Farmland Ownership and Tenure Survey). In today's rental market, approximately 30-40 percent of crop revenue goes towards farm rental expenses. Leasing arrangements are a top concern for Iowa producers and farmland owners. Rental agreement negotiations can be tense at times. In response, ISU Extension and Outreach ANR specialists served as an unbiased, research-based source of farmland leasing education. In this project period social distancing was observed in 31 in-person educational sessions, attended by 496 individuals. Sixty percent were non-farming landowners, 19 percent active farmers, 7 percent ag professionals. Through this e?ort and numerous others, direct contacts totaled 856 in 2020. Numerous local, regional, and statewide online sessions were held and recorded. These were attended by 117 and later viewed by hundreds more.

Of the 856 direct participants in these educational programs, 599 were invited to complete a post program evaluation. Approximately 95 percent of participants self-reported an increase in knowledge of leasing and legal issues and/or cash rental rates. Eighty-eight percent self-reported an increase in confidence to create meaningful change in their lease agreements.

Another Community and Economic Development e?ort is the Iowa Small Towns Project (ISTP), an integrated research and extension e?ort to better understand the conditions and issues facing small Midwestern communities and to provide support for the development of uniquely tailored activities to address the issues they face.

As a part of this project, a team of ISU scientists worked with six small towns with declining populations to discuss the results of his survey of households in 99 small towns in Iowa and identify priorities for their towns. He disseminated 73 town-level profiles, based on a large-scale survey. The profiles document the health and economic impacts of COVID-19, for communities' use in local planning and response e?orts. He also worked with community groups in four meatpacking communities to demonstrate how to use the profiles to advocate for workplace health, safety and economic improvements for black, Indigenous and people of color (BIPOC) and meat packing workers. As a result of his and others' e?orts, In Sac City, Iowa, the local development agency received a $20,000 Iowa Economic Development Authority grant for a feasibility study for reuse of the soon-to-be-shuttered middle school building and adjacent green space. In Elma, the town received a $1.2 million fund drive for conversion of an elementary school building into a community center for a new public library and childcare center. And in Bancroft, they pooled resources for a building to house a grocery store and a new distillery to bring in tourism. The ISTP survey data, town profiles, and focus groups helped identify these as priorities and helped secure the grants and fundraising e?orts.

The economic recession of 2007-2009 and business challenges since then have increased the need to better understand rural small business ownership (e.g., types of assistance needed, strategic options, new ways to compete in today's marketplace). Successful locally-owned businesses can enhance rural development and improve quality of life through their catalytic activities associated with economic development, entrepreneurship, and the development, marketing, and distribution of consumer related o?erings. In one project this period, a researcher focused on ways to enhance the entrepreneurial potential of two, sizable, but underserved populations in Iowa: women and older residents ages 50+, to engage in the start-up of food/hospitality-related (e.g., restaurants, local food vendors) and fiber-related (e.g., textile and apparel soft goods) businesses. Their previous research has shown these retail and service-based businesses to have helped to diversify and strengthen the economic base and character of many rural communities.

Interview and survey research this period determined environmental factors (e.g., community support, industry readiness and competition, available business assistance, and business/technology infrastructure) that are perceived to facilitate or deter the start-up of new food and fiber related business ventures for women and individuals age 50+. We also identified individual factors (e.g., personal attributes, motivations, family support) that are perceived to support or discourage business start-up for women and individuals age 50+ in Iowa.

In-depth interviews with the emphasis of the underserved groups' needs on education, training, and assistance were conducted with four small food business operators in Fairfield, Iowa. Interview data was assessed and adopted to create training videos. Videos were initially delivered in either face-to-face or online sessions with 10 business operators. The training videos were later made accessible to Extension professionals and residents across the 99 counties of Iowa.

Through refereed and invited presentations, publications, grant proposals, and student-learning activities, the team increased knowledge and provided strategic information to academic researchers, business/economic development specialists, and businesses owners about new approaches for improving economic well-being and business sustainability in rural Iowa communities.

Critical Issue: Food Production and Agricultural Systems

The thermal properties of soil a?ect many important soil attributes, including evapotranspiration, infiltration, water storage for plant use, drainage and how chemicals move in soils. Scientists have been studying soils for a long time, but this is an area where they are still learning. This year Robert Horton, who holds the Charles F. Curtiss Distinguished Professorship in Agriculture and Life Sciences in agronomy at Iowa State University, is one of the senior scientists recognized by USDA with its national Multistate Research Excellence Award for 2021 for his part in the long-running project, "Soil, Water and Environmental Physics to Sustain Ag and Natural Resources, or better known as W4188. This year, the team, including graduate students and a group of faculty, developed a new dual-probe heat pulse sensor to simultaneously measure soil thermal properties, soil water content and soil water matric potential. A series of experiments were performed to evaluate the sensor performance. The new sensor e?ectively measured soil water matric potential, soil water content, and soil thermal property values. Over time, scientists learned they could garner much more information from the sensor, such as heat energy moving in and out of soil and how much ice is forming or melting in soil, something we don't believe any other sensor can do. It can also measure bulk density to help gauge soil compaction and how it changes and impacts other soil conditions over time. The Thermo-TDR tool is primarily being used now by researchers for field measurements. The data it provides are also being used to improve modeling that forecasts how soil conditions change over time in response to changes in weather and climate. This is the first step toward developing a commercial sensor that can be broadly used to monitor soil water status.

Accurate weather forecasts for the US Corn Belt allow farmers to identify optimal periods of planting and harvesting, and lead to more accurate predictions of harvest yields. ISU researchers are working to improve weather and climate forecasts made by using satellite observations of soil moisture in the first few centimeters of the Earth's land surface. Soil moisture is important because it influences how water and energy move between Earth's surface and atmosphere, thus a?ecting weather and climate. This FFY, one of our research groups used soil moisture measurements from two relatively new satellites: NASA's Soil Moisture Active Passive (SMAP) mission; and the European Space Agency's Soil Moisture Ocean Salinity (SMOS) mission. This project year, they were able to confirm that satellite soil moisture observations are more often accurate in regions of the state with fewer row crops and less often accurate in regions of the state with more row crops. Data from this study advances the science needed to improve the satellite algorithms.

Understanding how genome stability is maintained and how genomic changes occur is important for modern agriculture, which relies of genomic manipulation, whether by conventional breeding, recombinant DNA technology, or genome editing, to generate novel strains of plants and animals. Much has been learned about the composition (DNA sequence) of the genomes of important agricultural species. However, there are important aspects of the functioning of genomes that are not well understood. In one project this year, we investigated how epigenetic modifications of chromatin proteins carried out by the JIL-1 kinase a?ect the systems that control mutation, recombination, and the repair of DNA double strand breaks (DSB). DSB are serious threats to genome stability. A single unrepaired DSB can cause death or significant developmental damage to a cell, so they must be repaired to restore genomic integrity. Our studies this year confirmed that JIL-1 has a role in DSB repair. This finding is a significant contribution to the scientific understanding of genome structure, function, and stability. No similar study has been done before.

Poultry provides a major animal protein source for human diets. The US industry must continue to genetically improve the production stocks and needs fundamental scientific information about the genetic control of important biological traits in order to do so. One project team at ISU determined that genetic lines of chickens that are relatively more resistant or susceptible to avian influenza virus have di?erent expression of genes related to immune function, especially the interferon pathway. They developed a genotyping platform to analyze African chicken lines and determined that there are multiple regions of the genome each explaining over one percent of the response to Newcastle Disease Virus. They demonstrated moderate heritability of several important biological traits in these chicken populations. This new scientific knowledge enabled other scientists to begin to build future studies on this information. Poultry breeding companies can use this information within their in-house programs for animal genetic improvement. Future application of this information will increase e?iciency in production of eggs and chicken meat, resulting in better food security.

In 2019, major packers announced Beef Quality Assurance Transportation (BQAT) certification would be required for all beef cattle transporters and producers directly delivering cattle to their packing plants. Iowa State University Extension and Outreach Beef Quality Assurance (BQA) program expanded in response to this. In 2019, 198 BQAT participants were certified in eight separate trainings. To measure the impact of the BQA and BQAT training, a survey was administered late in 2019 through mid-2020 to participants attending seven unrelated beef programs across the state. This sampling strategy yielded completed surveys from 146 producers representing various segments of the beef industry (41% cow-calf, 5% stocker, and 60% feedlot). Because of overlap, these percentages total over 100

percent. Respondents were asked what changes they made in their operation as a result of BQA and BQAT training. Forty-nine percent changed their cattle handling or processing area, which improves both cattle welfare and productivity. One producer summed it up well, "Continue to handle cattle quietly and try to get other people to treat cattle quietly." Forty percent changed their cattle health program, improving both animal health and profitability. Thirty-four percent shared with consumers how they manage their cattle to provide high-quality, healthy beef.

In Iowa, about 23 million acres are annually planted with corn and soybeans. The fertility costs of an acre of corn average over $100, and for soybeans approximately $54 per acre. Utilizing farm inputs e?ectively can make a big impact on the cost of production and economic e?iciency of crop production. Additionally, there are significant environmental concerns regarding nutrient loss when nutrient applications are placed incorrectly and when nutrients are over-applied. The objective of our statewide soil fertility workshops is to help producers understand how to wisely spend dollars to maintain high yields, reduce unnecessary expenditures, and protect soil and water quality while increasing farmer and landowner skills in interpreting soil test results and increasing farmer and landowner confidence in formulating their own soil fertility plan based on interpretation of the soil test results. The target audience for our soil fertility workshops includes farmers, landowners, and industry professionals. Understanding and implementing soil fertility recommendations ranked as the highest need in the five choices of programs o?ered to our target audience via a needs assessment. As a result of this needs assessment, field agronomists developed learning objectives, curriculum, worksheets, and teaching slides. Additional resources such as ISU fact sheets were identified and provided as supplemental handout materials to aid in decision-making. Workshops used ISU research-based recommendations and local agronomist knowledge to deliver relevant, hands-on information via 17 in-person workshops in 2019 and 2020, and via two virtual workshops held in early 2021. Workshops reached 225 people and plans exist to continue this e?ort now that COVID restrictions are lifted. This audience benefits from these workshops by being able to more e?ectively use dollars allocated for crop nutrition by placing them where they are needed, thereby reducing over-application, while maintaining yields that maintain farm income.

Critical Issue: Health, Nutrition and Well-being

Among the estimated two million agricultural workers in the United States, physicians diagnose 10,000 to 20,000 pesticide poisonings each year. The National Institute for Occupational Safety and Health (NIOSH) established the Sentinel Event Notification System for Occupational Risks – Pesticides Program (SENSOR- Pesticides) in 1987 to reduce the number of injuries and illnesses associated with occupational pesticide exposure. Among persons exposed to insecticides, the chemical classes most often involved are pyrethroids, organophosphates, sulfur compounds, and pyrethrins. Organophosphates (OPs), nerve agents, are a class of lethal weapons of mass destruction that kill by disrupting the nerve transfer mechanism. Unfortunately, these highly adhesive and volatile nerve agents are colorless, odorless and tasteless, making detection very di?icult.

In order to address detection challenges, we developed novel nanofiber-based sensors to detect the pesticides for chemical protective clothing. This research addresses the urgent need of safety protection for farmers and personnel working in hazardous environments, including firefighters and soldiers.

In other research, a study of rural Iowa Latinx immigrant families revealed that workplace conditions and lack of access to adequate health care services placed Latinx immigrant parents at risk of being exposed to COVID- 19 and spreading the virus to family members and others. The same study found that faith, emotional and tangible support from family members, friends, local churches, and adhering to health advice (e.g., wearing masks, social distancing as feasible, etc.) helped safeguard families' health and wellbeing during the pandemic.

In other research, we developed and tested novel community interventions to improve diet in Latinx populations and children living in rural areas of the state. New approaches for processing milks and developing emulsions that aid in the creation of healthier food products were investigated and the results communicated to industry partners.

Our university has a long-standing relationship with communities in Uganda. About 38 percent of Ugandan children under 5 years old are clinically deficient in vitamin A. Vitamin A is needed to support the immune system. Children who are deficient have a higher risk of dying from infectious diseases such as diarrhea or measles. This year, our research was able to confirm the bioavailability of pro-vitamin A in enriched bananas, as a dietary intervention to alleviate vitamin A deficiency in Ugandan children under the age of five.

Our SNAP-Ed and EFNEP programming, in nutrition education and healthy food access, reached 730 adults via 5,228 direct education sessions in 14 counties. In post-attendance surveys, youth and adults reported the following results: youth increased their frequency of vegetable consumption by 33 percent and fruit consumption by 38 percent; adults increased their frequency of vegetable consumption by 46 percent and fruit consumption by 30 percent.

Servsafe® is a food safety training program developed by the National Restaurant Association to provide food service workers with the knowledge they need to protect the public from foodborne illnesses. In 2021, our Servsafe® workshops were o?ered in every region of the state and were attended by 2,033 Iowans. Seventy- seven percent were able to obtain certification.

As a part of a research project, we conducted mosquito and tick surveillance in the state of Iowa to better understand the abundance and ecology of these arthropod vectors and the diseases that they transmit. When paired with the long-term data set of surveillance e?orts from previous years, these data can inform trends in vector abundance and vector-borne disease transmission risks. In addition to generating reports for local and state public health o?icials, mosquito and tick surveillance results were disseminated through local, regional, and national databases to serve the greater community of public health professionals, mosquito control professionals, and academic researchers interested in medical entomology and disease ecology. Results were also shared with other members of the Upper Midwest Center of Excellence in Vector Borne Disease, initiating conversations of vector-borne disease surveillance outside of traditional state borders.

Critical Issue: Human Potential and Youth Development

Our educational program entitled "Essentials to Child Care" has been added to state licensing requirements for all Iowa childcare teachers and providers. With the childcare workforce turnover reported at 35-55 percent annually, demand for this online education program is high. This FFY, a total of 6,697 unique individuals completed one or more of the 12 modules successfully. Participants received a certificate for each module successfully completed. Examples of module topics include "How to Create a Safe Environment for Young Children," Prevention and Control of Infectious Diseases," and "Supporting Cultural Diversity." Childcare providers who complete certification through this course benefit from accreditation in their field and competence in skills related to their profession.

Misinformed income-tax filers miss out on benefits they are entitled to. A trained tax preparer can help filers avoid missteps, however, the average tax preparation fee was $175 in 2021, making these services unaffordable for many Iowans.

The IRS's Volunteer Income Tax Assistance (VITA) program offers free tax help to people who make $54,000 or less, persons with disabilities, the elderly and limited English-speaking taxpayers who need assistance in preparing their own tax returns. IRS-certified volunteers provide free basic income tax return preparation with electronic filing to qualified individuals. In FFY21, three of our program specialists trained 68 volunteers to complete the IRS certification exams required for assisting others with tax preparation. Also, through outreach and administrative support, thirteen county extension offices across Iowa assisted nearly1400 Iowans with low- and moderate-income to access free, accurate tax preparation and to connect to critical tax credits.

According to the National Alliance on Mental Illness (NAMI), In February 2021, 42 percent of Iowa adults reported symptoms of anxiety or depression. Of the 154,000 adults in Iowa who did not receive needed mental health care, 29 percent did not because of cost. Similarly, 58 percent of Iowa youth aged 12-17 who had depression did not receive any care in the last year. In Iowa, 490 lives were lost to suicide and 129,000 adults had thoughts of suicide in the last year. In response to the needs of Iowans to provide care and support for friends and family members who experience mental illness, we offer education through Extension and Outreach programs. In this FFY, we reached 295 participants in 22 virtual workshops entitled Mental Health First Aid. Each workshop included 6-hours of instructor-led education and two hours of pre-course work. Our workshop entitled "Question, Persuade, Refer," was offered in 19 one-hour online workshops and one in-person workshop. A total of 224 Iowans participated. Participants include agribusiness professionals and producers, commodity group representatives, mental health advocates, formal and informal educators, and laypeople. In the post-course assessment, 88 percent of participants agreed or strongly agreed they feel more confident in asking anyone directly whether they are considering killing themselves. Participants also increased their knowledge and confidence in using action plans to refer an individual in crisis, or who may be suicidal, to appropriate professional resources.

The 4-H Youth Mental Health Survey administered by the National 4-H Council in 2020 reported that 82 percent of youth wished America would talk more openly about mental health (National 4-H Council, 2020). Also in 2020, a Center for Disease Control and Prevention study indicated rates of suicide among youth and young adults ages 10-24 increased 57 percent between 2007-2018 (Curtin, 2020). Stress can also increase participation in risky, unhealthy behaviors. Research shows daily mindfulness practices can have a significantly positive impact on a person's overall health and wellness, including mental and physical health (Creswell, 2017). Iowa's 4-H program offers workshops to help teens use mindfulness for better focus and concentration, improved self-awareness and regulation, increased empathy, compassion, and understanding, decreased stress, anxiety, and depression, increased self-esteem and improved sleep, relationships, and performance in school, work, sports, and other activities. The course is entitled "Mindful Teen: From Surviving to THRIVING!" It is a six-session curriculum based on the book, The Mindful Teen: Powerful Skills to Help You Handle Stress One Moment at a Time. In FFY21, 691 youth in 14 different counties participated in the training. Youth who engage in the Mindful Teen program indicate they have effective strategies to cope with stress and possess new strategies to address emotional highs and lows.

Critical Issue: Natural Resources and Environmental Stewardship

Our Master Conservationist Program aims to increase knowledge of Iowa's ecosystems and knowledge of conservation practices that help sustain and protect Iowa's natural resources. Participants are encouraged to share what they learn with people in their communities.

Each year, several counties throughout Iowa organize and lead the Master Conservationist Program. The seven-week program is laid out in a flipped classroom style. Participants watch recorded lectures and complete assigned readings before attending in-person field sessions with natural resources professionals. Topics covered in the program include understanding Iowa's ecosystems such as prairies, forests, and watersheds; land and water conservation in Iowa; and how to plant seeds of conservation in their communities. After completing the online modules, each person participates in a field day with a local conservation professional.

In 2021, each participant was sent two online surveys; one at the start of the course to assess knowledge, and one after completion of the field day. Ninety-seven percent of respondents to the post-course assessment reported the online materials "improved their learning experiences in the program." To measure planned changes in land use and resource stewardship behaviors resulting from participation in the program, participants were asked if they planned to implement practices or principles learned on land they own or have influence over. All 91 respondents who answered this question replied "yes."

When temperatures and humidity begin to rise, Iowans head to the waters of Iowa to swim, boat and fish. Iowa has an abundance of parks and water bodies available for recreation. Iowa's park system is one of state government's most popular programs. Visitations skyrocketed to a record 16.6 million last year, amplifying an upward trend since 1995. In a state where most of the land is used for agriculture, research and extension targeting the preservation and, in many cases, restoration of water quality is extremely important.

In Iowa's 2020 impaired water listing, the most recent assessment of Iowa's waterbodies, only one percent of water segments assessed achieved all water quality standards for their designated use. This reality is also expressed nationally. Iowa is one of the major contributors to the Gulf of Mexico Hypoxic Zone, an area of very low oxygen that has resulted from farm nutrients like nitrogen and phosphorus being deposited in high concentrations into the Mississippi River and its tributaries. In 2012, Iowa developed the Iowa Nutrient Reduction Strategy (INRS), a statewide e?ort to reduce nitrogen and phosphorus loads. Iowa State University research and extension have several projects and programs to assist with the work needed to reach the goals of the INRS. Some 2021 activities and results follow below:

An analysis of optimal nitrogen (N) applications in Iowa under abnormal rainfall was completed. We found the profitability penalty for incorrect nitrogen application doubles under abnormal rainfall. As a result, environmental damages and environmental protection costs increase. Results were published and presented at a regional conference of producers, agribusiness, and scientists. The anticipated outcomes of this work are a reduction in producers' uncertainty associated with costs and benefits of conservation practices, and a resulting increased adoption of those practices.

Three drainage water quality studies documented nitrate-N loss reductions of 20-40 percent. Reduction was proportional to cover crop biomass growth. Two drainage water quality studies showed there is little di?erence in nitrate loss between fall nitrogen application and spring nitrogen application when fall N application occurs when soils are 50 degrees Fahrenheit and cooling. Results from five years indicate a statistically significant reduction in nitrate-N concentration when split N application is used.

One new saturated bu?er was established on private land in Buena Vista County, IA. This new site, along with ongoing research at 16 sites installed across Iowa investigated the e?ectiveness of saturated bu?ers in removing nitrate. In total, over 50 total site-years of data have been collected as part of this research. Water flow and nitrate in the tile outlets, diverted into the bu?ers, and nitrate concentration changes within the bu?ers were monitored throughout the year at each site. Results showed that all the saturated bu?ers were e?ective in removing nitrate from the tile outlet. The annual removal e?ectiveness ranged from 12 to 92 percent. The project also identified barriers to farmer adoption of this and other practices.

Specific outcomes regarding several practices were detailed in a report to Iowa's Nutrient Research and Education Council. This new knowledge was also shared with vested stakeholder groups, direct contact with farmers and farmland owners through research being conducted on their farms; presentations at field days, conferences, ISU Extension trainings, and webinars; and through ad hoc meetings and direct consultation. Results have also been disseminated through peer-reviewed journal articles.

In 2021 we held two Iowa Watershed Academies for current Iowa watershed coordinators. The fall Academy focused on edge of field practice outreach, surveying, and cover crop management. A post-Academy survey was sent out to the 30 participants of the fall Academy; 67 percent responded. Eighty-five percent reported they agree or strongly agree they learned something valuable about edge

of field practice surveying, 75 percent reported they agree or strongly agree they learned something valuable about cover crop management, and 70 percent reported they agree or strongly agree they learned something valuable about strategies for outreach and being a successful watershed coordinator.

In one research project, researchers created a tool to integrate enclosed depressional wetlands (often called "prairie potholes") into watershed conservation plans. Prairie potholes can serve as natural sponges that hold excess rain and snowmelt, thereby reducing the risk and severity of downstream flooding. In Iowa, many prairie potholes are used for cropland. Originally, scientists instrumented a total of seven prairie potholes and monitored ponded water depth during the growing seasons of 2016-2019, which allowed us in this project period to assess the frequency of flooding, spatial extent of ponding when flooded, and duration of ponding events. Water quality was monitored daily during days of inundation greater than 10 cm in depth from 2016- 2018. For the two potholes that were part of this original project, the depth and quality data have been uploaded to the EPA Water Quality Portal, which makes them publicly available.

Researchers then developed a tool and a strategy to assess the connections of prairie potholes located downstream of water bodies (to clarify whether these depressional wetlands should be defined as "Waters of the U.S." as per the Clean Water Act) and include impacts of enclosed depressions in watershed planning e?orts. The tool developed under this project has been posted on the web, along with training materials, and presented to the scientific and lay communities through public and institutional webinars.

Farmers now have a dedicated tool to investigate whether management changes to their farming of prairie potholes may reduce the risk of flooding, or in the case of land retirement options may reduce the risk of economic losses due to flooding. Extension specialists, crop advisors, and other consultants can also use this tool. Policymakers and decision-makers have a method to potentially integrate prairie pothole restoration e?orts into watershed protection plans. Producers and planners have another tool in their toolbox for protecting water quality in the Waters of the U.S.

Critical Issue: Transformative Technology

In 2012, a team of three Iowa State University scientists developed PhenoBot, a state-of-the-art image-based platform for tall biomass crops to generate large data sets of plant architecture traits during the entire growing season. In FFY21, e?orts were put into the improvements of the PhenoBot design, instrumentation, navigation control, and the redesign of our 3D stereo vision module: PhenoStereo. In addition to new algorithms for maize plant stalk size sensing and leaf angle measurement, new algorithms for maize plant leaf area sensing and soybean plant seed pod characterization are being developed.

Understanding soil-tool interaction can enable better control of weeding tools to achieve higher weeding e?icacy. The interaction between a vertical tine mounted on a rotating disc and soil was investigated using a mathematical model that estimated soil horizontal forces on the tine operating at di?erent linear and rotational velocities. The research showed that the variations in shear and inertial forces on the tine were due to di?erences in soil failure patterns across the treatments. Predicted forces for two tines using the model showed trends that were similar to the forces measured in the experiment. These results are helpful for the development of physical weeding tools that have weed control e?icacies similar to those of chemical weed control approaches without the need for costly and dangerous inputs.

A new state-of-the-art o?-highway vehicle chassis dynamometer was installed at the ISU Agricultural Engineering and Agronomy Research Farm. What does a dynamometer do? This specialized, large-scale equipment enables controlled, dynamic testing of complete o?-highway vehicles with advanced traction control systems. Our facility is designed to test vehicles up to 450 kW (600 Hp), with speeds of up to 80 km/h (50 mph) and o?ers independent monitoring and loading of each wheel. The chassis dynamometer will be one of the few facilities capable of testing large construction and farm machinery. Possible tests: fuel-to-wheel energy e?iciency, drawbar power test, high speed test, dynamic braking test, simulation of uphill/downhill driving and braking, hill cresting test, and startup torque test.

In related agricultural vehicle work, hydrostatic and hydro-mechanical transmissions are commonly used in o?-highway vehicles. While both transmission technologies can provide continuously variable torque or speed ratios, they su?er from poor e?iciencies and limited operating ranges. Electric variable transmissions, in contrast, o?er complementary strengths via higher e?iciencies at low forward and reverse speeds, full torque from zero to full power, and increased control capabilities. A physical modeling methodology was developed to explore di?erent power-split transmission technologies using hydraulic, electrical, and mechanical pathways to understand how the complementary nature of the technologies could be used for overall power transmission performance.

Results from all our experiments have been distributed through traditional methods of peer-reviewed publications as well as directly to agricultural producers. The applied nature of this research is well suited for joint distribution both to the scientific community as well as direct distribution to producers and retailers who can immediately implement this new knowledge. Of particular interest was the focused delivery of planting systems and fertilizer application technology information directly to ag retailers through a series of extension and

outreach meetings. Feedback from these meetings documented both the high value of this research e?ort as well as the timely nature of these results which helped to address several short-term challenges for producers and retailers. This information has since been incorporated into internal training and best practice materials for over a dozen ag retailers, crop service providers, ag equipment dealers, and insurance companies in the Midwest. On an annual basis this approach to "train-the-trainer" will help ensure the long-term impact and use of these results to enhance agricultural productivity and environmental sustainability.

Use of whole-genome (genomics) tools and perspectives to improve the genetics of U.S. animal-based commodities has been adopted by nearly all food and fiber animal-breeding industries. The constant advancement of next-generation sequencing (NGS) technologies coupled with the exponential decreases in sequencing costs, have produced seismic shifts in research approaches and have substantially broadened the scope of animal genomics. Harnessing the power of big data in agri-animal genomics research is only possible through coordinated teamwork e?orts such as those successfully exhibited by the NRSP-8 species consortia. We have developed new genomic information, including data on genetic variability and functional genome annotation, as well as increased public access to such data and shared tools and resources. Due to this e?ort in coordinating scientists across multiple stations, we increased the knowledge of genome function for pig and other domestic animal species. This is documented in the many papers published and meetings attended in the past year. This information can be used by at universities and breeding companies to analyze their animal's genetic makeup and accelerate genetic improvement.

Merit and Scientific Peer Review Processes

Updates

As the pandemic and other challenges continued in 2021, ISU Extension and Outreach focused additional effort and resources to help Iowans and their communities move forward in every county.

- 44 counties are focusing on reviving the Iowa economy, including the farm economy. As a result, small businesses, entrepreneurs, agribusinesses, and farmers are connecting with education and resources so they can remain financially solvent, find alternate markets, and increase their profitability.
- 7 counties are supporting Iowans in improving financial security. Individuals and families are learning how to prioritize bills, protect credit, and manage debt.
- 12 counties are engaging Iowans in improving food supply, safety, and access. These efforts address local needs including nutrition education, donation gardens, farmers markets, and food system coalitions.
- 17 counties are expanding educational opportunities for youth with programs that spark youth interest, support academics, and promote youth resiliency.
- 8 counties are supporting efforts for increasing access to quality child care by networking with community partners and connecting providers with education.
- 30 counties are engaging Iowans in addressing mental health and providing access to research-based training and education on mental health literacy and suicide prevention.

These county-level efforts created or strengthened over 200 partnerships and coalitions and reached 30,499 Iowans. (As reported by counties in December 2021. Counties may have reported on more than one initiative.)

Stakeholder Input

Actions to seek stakeholder input that encouraged their participation with a brief explanation

None

Methods to identify individuals and groups and brief explanation

None

Methods for collecting stakeholder input and brief explanation

None

A statement of how the input will be considered and brief explanation of what you learned from your stakeholders

None

Highlighted Results by Project or Program

Critical Issue

Community and Economic Development

Iowa Farmland Leasing Education Program

Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7000126

⭐ Iowa Farmland Leasing Education Program

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Farmland is a limited resource for Iowa producers. With an aging landowner population combined with annual farmland changes, farmland leasing programs and educational materials and decision tools, are of great value to Iowa clients. Over half of Iowa farmland is owned by someone who does not currently farm, of which 34% is owned by owners with no farming experience and the remaining 24% is owned by retired farmers (Farmland Ownership and Tenure Survey). In today's rental market, approximately 30%-40% of crop revenue is going towards farm rental expenses.

Leasing arrangements are a top concern for Iowa producers and farmland owners. Rental rates peaked in 2013 at $270/acre, and while values have shown slight declines the last few years, they still have not returned to levels seen prior to the increase in commodity prices. Personal finance pressures on aging landowner populations that rely on rental income for their livelihood put added pressure on lease negotiations. Rental agreement negotiations can be tense at times. ISU Extension and Outreach ANR specialists serve as an unbiased, research-based source of education. This leads to clients' increased ability to successfully thrive within agriculture's cyclical nature and benefits all Iowans by creating stronger rural and urban economies.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Thirty-one in-person sessions had a total attendance of 496 participants, averaging 16 people per session/location. Additional planning with county partners included rearranging locations to allow social distancing or finding a new, larger location to hold the program and limiting attendance. Field specialists all had a contingency plan in place that was shared with the rest of the team should they not be able to hold a session. This included virtual options or coordinating with their neighboring field specialist to cover a session. Nine sessions were either fully virtual or provided in a hybrid format with a limited number in a location and a virtual option to join for an additional 243 attendees. The audience consisted of non-farming landowners (60%), active farmers (19%), ag professionals (7%), and other (14%). As this program is held annually, participants are often repeat attendees, with 70% having attended at least one program in previous years.

A statewide focused webinar, held at the end of August 2020, was the virtual option promoted in areas of the state where the field specialist didn't provide another virtual option. This session also served as the contingency plan if a specialist were to fall ill or a planned program had to be cancelled for another reason. The statewide webinar "Issues impacting Iowa farmland owners and tenants for 2021", was ½ day format, with a charge to join, and multiple campus faculty in staff serving as speakers, with 117 attendees. Through all these efforts, total direct contacts totaled 856 for 2020, a 40% decrease from the year prior. In addition to these direct contacts, four pre-recorded videos were viewed 464 times and replays of the webinars were viewed 152 for total in-direct contacts of 616.

Briefly describe how your target audience benefited from your project's activities.

Of the 856 direct participants who engaged in the program, 599 were invited to complete a post-program evaluation. Thrity-two percent (189) of participants completed the survey.

Measure #1: Percentage of participants who self-report an increase in knowledge related to leasing, legal issues, and/or cash rental rates.

Leasing = 94%

Legal Issues = 97%

Cash Rental Rates = 95%

Measure #2: Percentage of participants who self-report an increase in confidence related to creating meaningful change in lease agreements.

Change to Lease Agreements = 88%

Measure #3: Percentage of participants who self-report the identification of two or more ISU Extension and Outreach resources that support favorable farmland lease agreement discussions between landowners and tenants.

Self-Report Two or More ISU Extension and Outreach Resources = 87%

Briefly describe how the broader public benefited from your project's activities.

The broader public benefits from participants' engagement in the Iowa Farmland Leasing Education Program by participants' increased ability to successfully thrive within agriculture's cyclical nature thereby benefitting Iowans by creating stronger rural and urban economies.

Municipal Professionals Academy
Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001650

MPA Outcomes Report

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

As part of city clerk job duties, job requirements often stipulate that clerks must maintain certification and participate in professional development each year. In addition, municipal clerk certifications must be renewed every three years and professional development contact hours are required for certification renewal. The Iowa Municipal Professionals' Academy (IMPA) provides in-depth training and useful, up-to-date information that will assist clerks and municipal staff in their everyday job performance and provides professional development contact hours for certification renewal.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The 2021 IMPA conference hosted 125 attendees that represented Iowa city clerks, utility clerks, finance officers, HR representatives and city administrators. There were an average of 58.5 attendees per session. Immediately after completion of IMPA sessions, attendees were given surveys on a 4-point likert scale rating their knowledge change per topic as a result of the course session.

Increase knowledge of new laws, programs, and technology affecting Iowa municipal government.

- Of the average 58.5 session participants, there was a **47.7%** increase in individuals who indicated that, as a result of the session, they increased their knowledge on a session topic from "no knowledge" or "some knowledge" to "fairly knowledgable" or "very knowledgable" as measured on post-session surveys.

Briefly describe how your target audience benefited from your project's activities.

Municipal staff and clerk participants benefit from an increase in knowledge of new laws, programs, and technology affecting Iowa municipal government and its communities. This improves their capacity to effectively do their work. In addition, the professional development hours contributes to re-certification which keeps these participants in good standing with their city councils. By maintaining their accreditation, municipal staff/clerks are also prepared to acquire their Master Municipal Clerk certification through the International Institute of Municipal Clerks.

Briefly describe how the broader public benefited from your project's activities.

Continual professional development of municipal staff/clerks and advancing within their fields have proven positive benefits not only for the staff, but for city leadership and municipalities. These benefits include ensuring municipal laws and codes align with state and federal law in accordance with current best practices. This ensures local government is functioning effectively and efficiently which leads to maintenance of government functions and services for local citizens.

Women in Agriculture
Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001417

⭐ **Women in Agriculture**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Women have vital roles in Iowa's agricultural economy. According to the USDA 2017 Census of Ag, nearly 35,000 women are making key decisions on Iowa's 86,000 farms every day . The census indicates a majority (60.9%) of these women also have off-farm careers. Women own 47% of all Iowa farmland according to the Iowa Farmland Ownership and Tenure Survey 1982–2017: A Thirty-five Year Perspective. Additionally, for the 2021 academic year, women are more than half (57.1%) of the undergraduates in Iowa State University's College of Agriculture and Life Sciences. Women in agricultural careers from legal services, to livestock production, research and land sales are helping keep Iowa vibrant and resilient.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

During the 2021 fiscal year, 11 multi-part sessions with 118 participants were held. The impacts of the COVID-19 pandemic were clear as class sizes were limited to allow for social distancing and each program added a virtual connection. This allowed participants to join the program virtually in its entirety or join for sessions they could not attend in-person for a multitude of reasons. These efforts to continue risk management education in the wake of the pandemic were recognized in evaluation comments such, "This was great. Having the online option was a perfect fit and allowed me to balance family needs with my learning. Thanks so much for your hard work in this strange time!".

The multi-part sessions offered across the state included:

- four multi-session "Annie's Projects" with 18 contact hours per course,

- two multi-session "Women Managing Horses" with 8 contact hours per course,

- one pilot course for "Women Marketing Grain" with 12 contact hours over 4 sessions,

- one course with 5-sessions and 15 contact hours for "Managing for Today and Tomorrow",

- one course with 5-sessions and 15 contact hours for "Women Planning Ag Businesses", and

- two courses with 4-sessions and 12 contact hours for "Women Managing Farm Finances".

Briefly describe how your target audience benefited from your project's activities.

All 118 participants completed post-session evaluations. Participants' shared the following:

Measure #1: Percentage of participants who self-report an increase in knowledge in all areas of risk management.

95%

Measure #2: Percentage of participants who self-report taking at least two action steps in the areas of risk management.

100%

Measure #3: Percentage of participants who self-report course attendance resulted in the formation of one or more beneficial work relationships.

73%

Examples of open-ended comments from post-course evaluations:

"[This course taught me…] How to look at people with different personalities and learn my own shortcomings. I honestly feel like I am more accepting."

"[The most important action step as a result of the Annie's Project course…] I have taken several steps already to improve our farm such as creating financial benchmarks and reviewing our fertilizer orders and maps. I look forward to using marketing skills as our grain markets hopefully recover. I've asked some important estate questions as my family has recently handled one and will have another in the next few years. Not to mention planning the transitions from my father to us."

Briefly describe how the broader public benefited from your project's activities.

With almost 50% of Iowa farmland being owned by women, it is anticipated the broader public benefits from Women in Ag programs by participants having confidence in their skills to manage economically successful farms that, in turn, strengthen the economic stability of the state's agricultural industry.

Social, Economic and Environmental Causes and Consequences of Demographic Change in Rural America
Project Director
David Peters
Organization
Iowa State University
Accession Number
1019418

Social, Economic and Environmental Causes and Consequences of Demographic Change in Rural America

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Rural America has experienced dramatic changes in social and economic conditions since the 1980s. Many small towns have experienced decline in terms of shrinking populations, job losses, and poorer community services. On the other hand, other small towns have grown markedly due to the agricultural production and processing sector, and due to rural suburbanization. In addition, many rural places are vulnerable to the health and economic effects of COVID-19. The goal of this project is to provide evidence-based strategies to help small towns be resilient to socioeconomic, health, and mental health challenges.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The major activities reported here address the goals of: (1) document nonmetropolitan population change, examine the dynamics of these changes and investigate their social, economic, and environmental causes and consequences; (2) describe the interrelationships between contemporary rural population change and inequality, prosperity, and well-being of rural people, places and institutions.

Most activities reported here are related to the Iowa Small Towns Project (ISTP), a survey of households across 99 small towns in Iowa, along with community-based research in selected communities. In the smart and connected communities project, Dr. Peters and others worked with six small towns with declining populations to help improve quality of life, through focus groups discussing ISTP results to identify priorities. This has generated $1.7 million in NSF funding, three publications, and one conference paper. In the rural COVID-19 project, Dr. Peters disseminated 73 town-level profiles from a large-scale survey. The profiles document the impacts of COVID for use in local planning and responses. He has also worked with community groups in 4 meatpacking communities to use the results to better advocate for BIPOC and packing workers who were especially impacted economically. This work has resulted in 73 web profiles, one publication, two papers under review, and one conference paper. In the community demographics project, Dr. Peters analyzed Census 2020 data to better understand legislative apportionment in Iowa, and how Iowa communities are changes in terms of population size and composition. This has resulted in 1 publication and 12 media spots in newspapers, radio, and television.

Briefly describe how your target audience benefited from your project's activities.

In Sac City, the local development agency received a $20,000 Iowa Economic Development Authority grant for a feasibility study for reuse of the to-be-shuttered middle school building and adjacent green space. In Elma, it was a $1.2 million fund drive for conversion of an elementary school building into a community center for a new public library and child care center. In Bancroft, it was pooling resources for a building to house a grocery store and a new distillery to bring in tourism. The ISTP data and focus group process helped identify these as priorities and helped secure the grants or fundraising.

Briefly describe how the broader public benefited from your project's activities.

The ISTP collects, analyzes, and disseminates data and information that helps Iowa's small towns understand the challenges they face and the potential solutions to address them. Besides the project website (https://smalltowns.soc.iastate.edu), results have been disseminated through 4 invited talks in surrounding states and internationally (Sweden), and through 17 unique media spots in state and national outlets that include newspaper, radio, television.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

COVID-19 has limited primary data collection through focus groups and interviews.

Publications

- "Resilient Micropolitan Areas in the Face of Economic Shocks: A Stakeholder Collaborative Agency Perspective." *Engineering Project Organization Journal* (February 2021), vol. 10. https://doi.org/10.25219/epoj.2021.00103

- "The National Drug Crisis - What Have We Learned from the Regional Science Disciplines." *Review of Regional Studies* 50:353-382. https://rrs.scholasticahq.com/article/18236

- "Finding Resilience in Unexpected Places: Why Design Still Matters in Shrinking Rural Communities." *Proceedings of the 2021 Intersections Research Conference: COMMUNITIES*. In press.

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- *Impact of COVID-19 in Iowa's Small Towns*. SOC 3100, September. Iowa State University Extension. https://store.extension.iastate.edu/product/16333

- *Population Trends by Race and Ethnicity: Findings from the 2020 Census*. SOC 3098, August. Iowa State University Extension. https://smalltowns.soc.iastate.edu/2021/08/19/census-2020-population-by-race/

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- "Experts Explain Initial Results From The 2020 U.S. Census And Where Iowans Are Living." *River to River, Iowa Public Radio*, aired 8/18/2021. https://www.iowapublicradio.org/podcast/river-to-river/2021-08-18/experts-explain-initial-results-from-the-2020-u-s-census-and-where-iowans-are-living

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⭐ Social, Economic and Environmental Causes and Consequences of Demographic Change in Rural America

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Sociological Research to Advance Sustainable U.S. and International Food Security and Rural Development

Project Director
J Arbuckle
Organization
Iowa State University
Accession Number
1013531

⭐ **Social determinants of health in rural contexts: Measuring the impact of environmental risk and protective factors**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Health and wellbeing in rural contexts differ from those in dense, population urban contexts, yet relatively less is known about the rural context. Rural communities typically have fewer built resources (e.g., hospitals, clinics, workforce development offices) to support health and wellbeing and more demanding transportation needs. Rural communities also have unique risk environments, flowing from natural and cultural factors. Understanding the risk and protective factors in rural communities expands our ability to know why some people/communities thrive while others suffer higher mortality, lower economic mobility, and greater social disorganization.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

With funding from CDC, SAMSHA, and the National Alcoholic Beverage Control Association, Dr. Dorius' research team created a substantial data infrastructure of rural communities. These data enable researchers, public health officials, government agencies, and non-profit groups (e.g. community action services) to better understand community risk and protective factors across Iowa. The data infrastructure includes geolocation and other information for every hospital, clinic, treatment center, school, park, child care center, peer support meeting, and workforce development office, to name a few. These community assets support individuals, families, and communities in their efforts to achieve high quality of life and resilience in the face of social, economic, and ecological risks. We also built the first data infrastructure on alcohol outlets in Iowa. These data help

policy makers, community leaders, law enforcement, and others to know about risk factors for car crashes, family instability, violent crime, and first responder calls for service in local communities throughout Iowa. Combine with additional social and economic data, we have substantially improved the ability or rural communities to make data informed decisions.

Briefly describe how your target audience benefited from your project's activities.

The Iowa Alcoholic Beverages Division, which is the state agency charged with the regulation and sale of alcohol in Iowa, now has a data dashboard to guide their policy decisions. City officials, local law enforcement, and community-based organizations in Burlington, Cedar Rapids, Iowa City, and Marshalltown now have data tools that help them to make data informed decisions that minimize alcohol related harms in their communities. These are first of kind tools in Iowa. People throughout Iowa who are in recovery from an substance use addiction now have a common set of resources to help them find the support they need, when they need it, thanks to our development of the *Recovery Iowa* website.

Briefly describe how the broader public benefited from your project's activities.

The goal of Dr. Dorius' work is bring data to bear on issues of community health and wellbeing. Toward that end, my team and I have created a large number of resources to support local communities in making data informed decisions. As part of that work, we engage with local communities, policy makers, state agencies, and non-profits to develop novel solutions to pressing problems in Iowa communities. As part of that work, I have co-administered numerous workshops and training sessions, reaching hundreds of participants, to demonstrate how data can be leveraged for decision-making. We developed the first of kind alcohol outlet density monitoring system for Iowa, the first of kind recovery website for Iowa, and a statewide assessment of the rapidly escalating risk of methamphetamine use in Iowa.

Critical Issue

Food Production and Agricultural Systems

Beef Quality Assurance Education
Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001617

⭐ **Beef Quality Assurance Education**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The Beef Quality Assurance (BQA) program expanded in response to two emerging challenges. First, there is increased demand for nutritious, high-quality beef, and second, consumers are requesting information about where and how their beef is produced. Hence, fed cattle market outlets embarked on a path in 2018 requiring feedlot producers to be Beef Quality Assurance (BQA) certified at the time of sale.

In 2019, major packers announced Beef Quality Assurance Transportation (BQAT) certification would be required for all beef cattle transporters and producers directly delivering cattle to the packing plant. Because of BQA and BQAT programs, consumers can be assured the beef they consume is raised responsibly and cared for properly. BQA and BQAT are also positive for beef producers. Beef producers can maintain market access, and these programs can potentially increase domestic and international demand for beef.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Iowa beef industry embraced these two challenges. Industry partners such as County Cattlemen's Associations, Livestock Auction Markets, the Iowa Cattlemen's Association, the Iowa Livestock Marketing Association, local veterinarians, feed companies, pharmaceutical companies, and coops offered to co-sponsor numerous local BQA certification workshops with

ISU Extension and Outreach's Iowa Beef Center and the Iowa Beef Industry Council. Beef producers, beef transporters, and industry consultants were the Iowa beef industry's target audiences.

During the period of August 10, 2017, through September 30, 2019, the ISU Extension and Outreach Iowa Beef Center and Iowa Beef Industry Council conducted 122 Beef Quality Assurance trainings certifying 6,754 beef producers and allied agri-business professionals. In 2019, 198 BQAT participants were certified in eight separate trainings. In most cases, BQA trainings were supported by grants from Tyson Foods, Cargill, National Beef, and registration fees.

Briefly describe how your target audience benefited from your project's activities.

To measure the impact of the BQA and BQAT training, a survey was administered late in 2019 through mid-2020 to participants attending seven unrelated beef programs across the state. This sampling strategy yielded completed surveys from 146 producers representing various segments of the beef industry (41% cow-calf, 5% stocker, and 60% feedlot). Because of overlap, these percentages total over 100%.

As a result of the BQA and BQAT training, respondents were asked what changes they made in their operation. 49% changed their cattle handling or processing area, which improves both cattle welfare and productivity. One producer summed it up well, "Continue to handle cattle quietly and try to get other people to treat cattle quietly."

40% changed their recordkeeping, which reduces possible residues and improves food safety. The most common change cited was better recordkeeping, with one person stating, "Had recordkeeping system in place before training, but added a more easy-to-read format for re-treating and history database."

Another 40% changed their cattle health program, improving both animal health and profitability. The number one comment was "Changed needles more often," which improves sanitation and the efficacy of the vaccine.

34% shared with consumers how they manage their cattle to provide high-quality, healthy beef. One producer said, "I have engaged with non-farm members of the public about the practices I use in my operation to make sure they have a better product when they make a food choice." Another producer pointed out the importance to the industry by saying, "Just being aware that consumers and meat companies are watching us closely."

But, sharing didn't stop with the consumer. 70% shared BQA information with up to 5 other people.   Using bracketed numbers and responses, an estimated 64 participants shared BQA information with another 283 people.

When asked to estimate the value of the BQA education and certification to their operation, values ranged from less than $100 to greater than $2000. Using midpoint values and the number of responses for each economic bracket, the conservative total was $45,200, which averaged $430 per operation.

Another positive result of the BQA and BQAT training was the outreach of the ISU Extension and Outreach Iowa Beef Center and the Iowa Beef Industry Council. 41% had not attended or used ISU Extension and Outreach materials prior to the training, but 38% would be more likely to do so in the future. Over 68% of the respondents were appreciative of the Iowa Beef Industry Council's work and the beef checkoff program that is done on their behalf, citing work in providing education and beef promotion.

Measure #1: In surveys administered up to three years following training participation, 30% of participants will report changing cattle handling and processing areas to improve handling and cattle welfare.

49%

Measure #2: In surveys administered up to three years following training participation, 35% of participants will report making changes to recordkeeping and health programs to improve animal health and food safety.

40%

Measure #3: In surveys administered up to three years following training participation, 30% of participants will report discussing their efforts to maintain safe, high-quality beef with consumers.

34%

Briefly describe how the broader public benefited from your project's activities.

It is anticipated the broader public will benefit from participants' engagement in the Beef Quality Assurance Education certification program by being assured the beef they consume is responsibly raised and cared for properly. Additionally, BQA and BQAT certification is also positive for teh braoder public because beef producers can maintain market access, and potentially increase domestic and international beef demand.

Iowa Farm to School and Early Care Program

Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001619

⭐ Iowa Farm to School and Early Care Program

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The US Centers for Disease Control report that obesity and associated health risks now affect one in five US children. Poor diet and lack of physical activity are the most-cited causal factors. Farm to school programming and activities have proven effective in creating healthier eating and outdoor activity habits in school children.

According to the United States Department of Agriculture's most recent 2019 Farm to School Census, 65.4% of US school districts participated in farm to school activities in school year 2018-19. Iowa responses showed 545 schools serving 224,028 students participated in farm to school activities, and 107 of them regularly include local foods on their menus.

A coalition of organizations supported and guided by the Farm, Food and Enterprise Development (FFED) Program of Iowa State University Extension and Outreach leads a growing program of farm to school and early care efforts in Iowa.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In January 2020, 24 key stakeholders from 15 farm to school and early care organizations met in Des Moines. The result of the meeting was the Iowa Farm to School Coalition and the Iowa Farm to Early Care and Education Coalition merged into the Iowa Farm to School and Early Care Coalition. The coalition's target audiences were Iowa youth and farmers and communities involved in, or who benefit from, successful farm to school and early care programs.

Three FFED team members represent Iowa State Extension and Outreach in the coalition. The unified organization developed a clearly defined vision and pathway for moving forward together. Stakeholders met for two days of facilitated discussion, activities, and strategy sessions. They established and agreed upon a group name, mission, vision statement, core values, structure, goals, objectives, and strategies.

Briefly describe how your target audience benefited from your project's activities.

The coalition's impacts for the 2020-21 program year included more than 250,000 children and youth at 1,110 schools and early care sites participated in Iowa farm to school and early care initiatives. A total of 434 school districts and early care sites procured local food for meal programs. In October 2020, despite COVID-19 challenges, 61 school districts in 35 counties still participated in Iowa Local Food Day, serving a total of 51,500 meals featuring local foods. The number of meals served compared to 2019 was down about 50% due to a reduction in students eating meals on-site as a result of virtual and hybrid learning models.

Iowa F2S and ECE programs were awarded more than $800,000 in grant funds to support statewide work. In 2020 - 2021, seven food hubs across Iowa sold $225,000 to schools, early care sites, and colleges. Of the $225,000 reimbursed to schools for local food purchases, 51 percent was spent at food hubs and 51 percent (41 of 80) of grantees were served by food hubs. The coalition also provided one-to-one technical assistance and created a web-based interactive list of resources for schools and early care sites facing COVID-19 challenges. For more information on this program, see https://www.extension.iastate.edu/ffed/f2s.

Measure #1: 400 school districts and early care sites will procure local food annually because of the coalition's work (2019 USDA Farm to School Census, 2019 Iowa Farm to ECE Provider Survey).

1,110

Measure #2: Food hubs will support/supply over 50% of all the local food purchases to schools and early care and education sites each year.

51%

Measure #3: 80,000 meals containing Iowa-grown foods will be served to Iowa pre-K–college students during Iowa Local Food Day (IowaLocalFoodDay.org) and the program will lead to more than $200,000 in local food purchases in 2020.

51,500 meals

Briefly describe how the broader public benefited from your project's activities.

It is anticipated the broader public will benefit from participants' engagement in the Iowa Farm to School and Early Care Coalition Program by providing income for local food growers and potentially decreasing obesity in children, youth, and college students by supporting healthier eating habits that consist of consumption of local, preservative-free, fresh, healthy foods.

Produce Safety Alliance Trainings Show Knowledge Gain

Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001684

⭐ Produce Safety Alliance Trainings Show Participant Knowledge Gain

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Fruits, vegetables, and nuts are among the most common sources of foodborne outbreaks and illnesses in the US. In 2017 alone, there were 841 foodborne disease outbreaks, resulting in 14,481 illnesses, 827 hospitalizations, 20 deaths, and 14 food product recalls (CDC, 2019). Very small to medium-sized produce growers and processors represent the majority of producers in the twelve north central region (NCR) states. In 2018, 41.5% of foodborne outbreaks in the US occurred in the NCR.

Ensuring the food safety of fruit and vegetables in the US has been an ongoing challenge because of the complexity of the growing environment, the diversity of produce growers, and the supply chain. The FDA's Food Safety Modernization Act (FSMA) is designed to prevent and respond to foodborne illnesses. The law consists of seven rules, including the Produce Safety Rule (PSR), which applies to those who grow, harvest, handle or pack fresh fruits, vegetables, and nuts that are typically eaten raw. One requirement of the Produce Safety Rule is that some fruit and vegetable growers take an approved food safety course. The Produce Safety Alliance (PSA) Grower Training Course is one way to satisfy the FSMA Produce Safety Rule requirement outlined in § 112.22(c) that requires '*At least one supervisor or responsible party for your farm must have successfully completed food safety training at least equivalent to that received under standardized curriculum recognized as adequate by the Food and Drug Administration.*' The overarching goal of this program is to reduce the incidence of foodborne illness associated with produce in Iowa.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Iowa Department of Agriculture and Land Stewardship and Iowa State University Extension's On-Farm Produce Safety Team has been offering Produce Safety Alliance (PSA) trainings since 2017. Trainings focus on increasing produce growers' knowledge of produce safety best practices related to growing, harvesting, packing, and/or holding of fruits and vegetables grown for human consumption. Before the pandemic, trainings were held in person, primarily at local county extension

offices. Due to the COVID-19 pandemic, the PSA allowed virtual trainings. In the winter/early spring of 2021, in partnership with University of Nebraska Extension colleagues, the Iowa On-Farm Produce Safety Team offered three remote Iowa PSA Grower Trainings.

The target audience of this program is fruit and vegetable Iowa growers who grow produce that are typically eaten raw and have profits greater than $28,561 annually. Very small to medium-sized produce growers represent the majority of Iowa producers. All fruit and vegetable growers were encouraged to attend this program.

Using a knowledge assessment tool developed by Dr. Catherine Shoulders from the University of Arkansas, participants' knowledge is measured pre-training and post-training. The knowledge assessment tool is a quiz consisting of 25 questions related to the PSA Grower Training's seven modules. 12 months after training completion, participants receive a follow-up survey asking them to indicate if they have implemented on-farm food safety practices as a result of what they learned at the PSA Grower Training.

Briefly describe how your target audience benefited from your project's activities.

Three remote Produce Safety Alliance Grower trainings were offered on January 13-14, 2021 (n=10), February 2-3, 2021 (n=21) and March 4-5th, 2021 (n=28).

- January 13th-14th, 2021, Remote delivery PSA training for 10 Iowa growers; this was a partnership with Nebraska. Presenters: Dan Fillius, Shannon Coleman, Angela Shaw, Joe Hannan, and John-Krzton Presson. Tech facilitation and hosting: Ellen Johnsen.

- February 2-3, 2021, Remote delivery PSA training for 21 Iowa growers; this was a partnership with Nebraska. Presenters: Dan Fillius, Angela Shaw, Joe Hannan, Morgan Hoenig, and Sarah Browning from University of Nebraska-Lincoln Extension. Tech facilitation and hosting: Ellen Johnsen.

- March 4-5th, 2021, Remote delivery PSA training for 28 Iowa growers; this was a partnership with Nebraska. Presenters: Dan Fillius, Joe Hannan, Anirudh Naig and Sarah Browning and John Porter from University of Nebraska-Lincoln Extension. Tech facilitation and hosting: Ellen Johnsen.

Knowledge gained was assessed through a pre- and post-test at each training. There was a 4.8 point out of 25 possible point increase between the pre-test and post-tests which is statistically significant. Iowa has a great many Plain growers who are Amish and Mennonite. The team hosted trainings for Plain growers but non-plain growers were welcome to attend. During these trainings, the average increase in pre- to post-tests was only 3.1 points out of a 25 possible point increase. At other trainings, the average was a 6.3 point increase out of 25 possible point increase. The highest knowledge gains were on Modules 1, 2, and 3. Participant scores revealed the lowest knowledge gain/loss for Modules 5, 6, and 7. As a result of these findings, the team is making additional efforts to provide supplemental education to our Plain grower populations through partnerships with local food hubs and food auctions.

A follow-up survey was sent to growers who participated in Produce Safety Alliance trainings in the past 12 months to learn how they have changed their on-farm food safety practices since attending the PSA grower training. One hundred and thirty complete responses were received from the 9 trainings in Iowa in 2019-2020. 88% of growers who responded to the survey reported making a change to on-farm produce safety practices.

Measure #1:

Immediately after completing the PSA Grower Training, 70% of participants will self-report an increase in their knowledge of produce safety practices related to growing, harvesting, packing, and/or holding of fruits and vegetables.

The percentage of participants who self-report an increase in their knowledge of produce safety practices related to growing, harvesting, packing, and/or handling of fruits and vegetables was not measured this year. However, there was an average 4.8 point increase between participants' (N = 59) pre-test and post-tests knowledge assessments. This finding was statistically significant.

Measure #2:

12 months after completing the PSA Grower Training, 60% of participants will self-report implementing new produce safety practices at the farm-level.

88% (N = 130)

Briefly describe how the broader public benefited from your project's activities.

It is anticipated the broader public will benefit from participants engaging in the PSA Grower Training Course by ensuring that producers implement food safety practices to prevent foodborne illnesses in the consumption of raw fruit and vegetables.

Soil Fertility Workshops Improve Profitability, Reduce Environmental Impact
Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001437

⭐ **Soil Fertility Workshops**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

In Iowa, about 23 million acres are annually planted with corn and soybeans. According to the 2022 ISU Extension and Outreach publication titled, "Estimated Costs of Crop Production", the fertility costs of an acre of corn averaged over $100, and for soybeans around $54 per acre. Utilizing these inputs effectively can make a big impact on the cost of production and economic efficiency of crop production - more so when commodity prices are low. Additionally, there are significant concerns for nutrient loss when nutrient applications are placed incorrectly and when nutrients are over-applied. All of these issues lead to economic, agronomic, and environmental concerns that place significant burdens on farmers and impact their decision-making.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The objective of the soil fertility workshops is to develop and offer statewide soil fertility workshops to help producers understand how to wisely spend dollars to maintain high yields, reduce unnecessary expenditures, and protect soil and water quality while increasing farmer and landowner skills in interpreting soil test results and increasing farmer and landowner confidence in formulating their own soil fertility plan based on interpretation of the soil test results. The target audience for the soil fertility workshops includes farmers, landowners, and industry professionals.

This audience will benefit from these workshops by being able to more effectively use dollars allocated for crop nutrition by placing them where they are needed, thereby reducing over-application, while maintaining yields that maintain farm income.

Understanding and implementing soil fertility recommendations ranked as the highest need in the five choices of programs offered. As a result of this needs assessment, field agronomists developed learning objectives, curriculum, worksheets, and teaching slides. Additional resources such as ISU fact sheets were identified and provided as supplemental handout materials to aid in decision-making. Workshops used ISU research-based recommendations and local agronomist knowledge to deliver relevant, hands-on, information via 17 in-person workshops in 2019 and 2020, and also includes two virtual workshops held in early 2021. These workshops reached 225 people and plans exist to continue this effort now that COVID restrictions are lifted.

Briefly describe how your target audience benefited from your project's activities.

A follow-up survey was sent via Qualtrics or mail to participants after the next growing season was completed to evaluate how they used the information presented to make decisions on their farm. It was imperative that this survey was deployed 8-12 months after the workshops to allow time for changes to be implemented at the farm. A total of 33 surveys were returned.

25 participants or 75%, reported being more confident in making fertilizer recommendations and reduced their fertilizer expenses while maintaining or increasing yields (N=12 or 36%). These respondents indicated that the knowledge gained was implemented on at least 11,400 acres, and 21(64%) participants estimated the value to their operation at over $5 per acre. Individual comments included saying that this helped them "put fertilizer where you need it versus everywhere," and "I appreciate all of it. We had little to no understanding and simply did what was recommended."

Measure #1: Within 8 - 12 months after completing the Soil Fertility Workshop, 75% of participants will self-report an increase in skills to interpret a soil test report.

75%

Measure #2: Within 8-12 months after completing the soil fertility workshop, 75% of participants will self-report an increase in confidence to formulate their own soil fertility plan.

64%

Briefly describe how the broader public benefited from your project's activities.

It is anticipated the broader public will benefit from participants' engagement in the soil fertility workshops by teaching producers strategies to apply the correct amount of nutrients at the right time and rate that leads to better water quality due to less nutrient loss through runoff to surface waters.

Predicting Genotype by Management by Environment Interactions across Scales
Project Director
Sotirios Archontoulis
Organization
Iowa State University
Accession Number
1020989

⭐ **GxMxE effects on productivity and sustainability**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The project addresses a major issue in agronomic research that is understanding and predicting the interaction between genotypes, management practices, and environmental conditions across scales. This project aims to increase our capacity to predict impact (e.g., crop yields), explain causes (e.g., water stress), and design strategies (e.g., cover crops) to increase profitability and environmental sustainability of Iowa cropping systems, including corn, soybean, perennial and annual cover crops.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We generated new research data to fill knowledge gaps (e.g., optimum N fertilizer to maximize root carbon), synthesized research data towards developing new prediction algorithms, 3) upscaled and disseminated via web tools to assist decision-making. During the reporting year, the project team performed more than 100 field experiments, published over 30 research papers, reached thousands of stakeholders through extension and research presentations as well as online decision support tools. Example field studies include the maize era study, in which we measured the genetic gain of Bayer's maize hybrids released from 1980 to 2020 in nearly 40 environments in the US Corn Belt.

Briefly describe how your target audience benefited from your project's activities.

Our target audience is producers (corn, soybean, cover crops, perennials), scientists, industry, and students. Crop producers benefited by accessing information via our online decision support tools (ISU Extension FACTS website and ISOFAST – see comments section). An example is the soil conditions web tool that provided real-time data on soil moisture levels across the landscape and the degree of crop water stress. Scientists benefited from our research publications on a variety of topics centered around Genotype x Management x Environment Interactions and modeling (see list of publications under comments). An example of experimental research is the publication by Ordonez et al. 2021 in which we found that excessive and insufficient nitrogen fertilizer reduces maize root mass across soil types in the US Corn Belt. An example of modeling research is the publication by Pasley et al. 2021 in which we found via modeling that the corn-soybean rotation has a larger buffering capacity (less risky system) than the corn-corn system in terms of nitrogen leaching. Students benefit by learning new techniques in field data collection (phenotyping), new techniques in data analysis (simulation modeling), and by working in multi-disciplinary teams.

Briefly describe how the broader public benefited from your project's activities.

Research, publications and presentations, conducted as part of this project, have provided farmers with timely information to improve decisions making and manage their crops; provided policy makers and industry with new data and improved models to cope with climate change projections and sustainability assessments

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Below is a list of publications during the reporting period

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Project Director

Brian Hornbuckle

Organization

Iowa State University

Accession Number

1018693

⭐ **Remote Sensing of Soil Moisture and Crop Water to Facilitate Improved Forecasts of Weather and Climate in the Corn Belt of the Midwest US**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The focus of this project is to develop satellite observations of Earth's land surface that will facilitate better weather and climate forecasts for the Corn Belt of the Midwest United States. These improved forecasts can be used to make decisions that increase the profitability of agriculture while maintaining or improving the quality of the region's natural resources. My current research centers around the use of two relatively new satellites: NASA's Soil Moisture Active Passive (SMAP) mission; and the European Space Agency's Soil Moisture Ocean Salinity (SMOS) mission. Each satellite is currently producing observations of soil moisture, and the water content of the first few centimeters of the Earth's surface. Soil moisture is important because it influences how water and energy move between Earth's surface and atmosphere, thus affecting weather and climate. However, soil moisture from SMAP and SMOS are "too dry" in the US Corn Belt when compared to measurements of soil moisture made by instruments buried in the ground, our best estimate of the "true" value, at a satellite validation site in central Iowa. My research group is working to correct this problem by critically examining the algorithms used to convert the raw signal measured by these satellites into observations of soil moisture, and by making careful ground measurements of soil moisture and an important confusing variable, vegetation (crops), which degrades the satellites' ability to "see" soil moisture.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

When it rains, soil moisture influences how much water infiltrates in the soil and how much does not. The "run off" water eventually makes it to streams, rivers, and lakes. If the soil is wet, run off is high and flooding can occur. The Iowa Flood Center makes continuous estimates of streamflow across the state in order to anticipate flood hazards. The Flood Center uses a computer model to simulate soil moisture values. In the future the Flood Center model will use satellite soil moisture observations to improve it's performance. We compared soil moisture observations from NASA's Soil Moisture Active Passive (SMAP) satellite and the European Space Agency's Soil Moisture and Ocean Salinity (SMOS) satellite with the estimates of soil moisture made by the current Flood Center model over the entire state. We found that overall satellite soil moisture is drier than what is predicted by the Flood Center model. SMAP observations more closely matched the Flood Center model estimates than SMOS observations. We also found that the spatial pattern of the mismatch between the Flood Center model and the satellite observations is similar to the spatial pattern of row crop agriculture in the state. We concluded that satellite soil moisture observations are more accurate in regions of the state with less row crops and less accurate in regions of the state with more row crops.

Briefly describe how your target audience benefited from your project's activities.

My target audience is the scientific community that is engaged in improving predictions of future weather and climate, as well as the agricultural industry engaged in monitoring crop progress and production. Because of our work, this target audience has a better understanding of the quality of existing satellite soil moisture observations, how they compare to existing model estimates, and how these satellite soil moisture observations need to be improved.

Briefly describe how the broader public benefited from your project's activities.

The broader public will benefit from this work via improved weather and climate forecasts. Satellite soil moisture observations will eventually be incorporated into weather and climate models to better simulate the exchange of water and heat between Earth's land surface and atmosphere, and thus allow better simulation of the movement of water and heat within Earth's atmosphere. Water from Earth's surface can either evaporate into the atmosphere or be transpired by plants.

This movement of water also influences the movement of heat because energy is required to change soil liquid water into water vapor that can enter the atmosphere. Better weather forecasts in the US Corn Belt will allow farmers to identify optimal periods of planting in the spring and lead to better predictions of harvest yield and its impact on the economy. Better climate forecasts will allow stakeholders to best anticipate what changes to the agricultural system must be made to best manage the impacts of climate change.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

This work is documented here: https://doi.org/10.1109/JSTARS.2021.3131133.

Closing Out (end date 09/07/2023)

Improving Soybean Arthropod Pest Management in the U.S.

Project Director

Matthew O`Neal

Organization

Iowa State University

Accession Number

1017861

⭐ **Molecular markers to identify insecticide-resistant aphids**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Overall, this project is trying to solve the problems caused by insect pests that attack soybeans. We explore multiple tools to prevent pest outbreaks, and manage those that occur. This requires studies that span ecology to biochemistry. In this project we are exploring the occurrence and source of insecticide resistant aphids that attack soybeans.

Soybean was first domesticated in China and many of the insects that co-evolved with the plant are not found in the regions that currently produce the majority of soybeans (e.g., USA, Brazil, and Argentina). Historically, the majority of the insects that colonize soybean did so through novel associations. The number of pests that attack soybeans in North America has increased due to the accumulation of invasive species from Asia. For example, the soybean aphid, *Aphis glycines* is one such invasive that has altered the pest management practices of soybean growers, especially in the leading soybean producing states (Iowa, Minnesota, and Illinois). Before the aphid arrive soybean were grown in this region with very little, if any, insecticide applications; after the arrival of *A. glycines* and its rapid spread across the North Central region of the US, growers have dramatically increased the use of insecticide, ranging from 4 to 14 million hectares per year. Although *A. glycines* was noted as an important pest of soybean in its native range, its impact in the US has been markedly greater than that within its native range (Liu *et al.*, 2004; Ragsdale *et al.*, 2004; Wu *et al.*, 2004). The economic impact of *A. glycines* is two-fold; a possible source of yield loss that can reach 40% or more if left untreated and increased input cost that range from $16 to $33 per ha. The research conducted as part of an earlier version of this project contributed to the recommendations that both prevent this yield loss as well as limit the unnecessary use of insecticides. Overall, this has produced an estimated savings to growers of $1.3 billion during the initial 15 years of *A. glycines* occurrence in the US using the current rate of adoption of the IPM-based recommendations.

After multiple years of insecticide use, the soybean aphid, *Aphis glycines* (Hemiptera: Aphididae), has evolved resistance to pyrethroids in the United States.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We developed molecular markers to more quickly identify insecticide-resistant aphids. These markers are being used to assess the frequency of pyrethroid-resistant aphids in Iowa. Our results demonstrated a strong association between field-collected aphids with these *vgsc* mutations and survival consistent with the resistant phenotype. These diagnostic tools can be used for detecting resistant *A. glycines* and monitoring the geographic distribution of pyrethroid resistance. In addition,

these markers can be used to detected resistant aphids without running timing consuming bioassays. These research findings can improve our efforts to mitigate the effects of pyrethroid resistance on soybean production and inform farmers to improve management strategies.

Briefly describe how your target audience benefited from your project's activities.

Multiple farmers have expressed interest in having the soybean aphids found in their field tested for the mutations associated with pyrethroid resistance.

The soybean checkoff program has agreed to support this type of survey in Iowa. As we expand the detection of pyrethroid-resistance, we can help farmers prevent its spread. Informing farmers of what insects are in their field can help us inform farmers if they need to switch to a different insecticide to prevent soybean aphid outbreak.

Briefly describe how the broader public benefited from your project's activities.

Insecticide resistance is a troubling problem that can cause significant environmental and economic problems to farmers. If farmers do not react quickly, they may continue to waste money on an insecticide that is not working but could kill other, non-target insects. Multiple insecticide applications also cost farmers money, both in terms of products that do not work, but also in terms loss yield.

By publishing the type of markers that can be used to detect these mutations, there is potential for agribusiness to further develop scouting tools for certified crop advisors and farmers.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Publications:

Valmorbida, I., Coates, B.S., Hodgson, E.W., Ryan, M. and O'Neal, M.E. 2022. Lack of fitness costs and evidence of enhanced reproductive performance among soybean aphid, *Aphis glycines*, with varying levels of pyrethroid resistance. *Pest Management Science,* https://doi.org/10.1002/ps.6820

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Closing Out (end date 09/07/2023)
Advanced Technologies for the Genetic Improvement of Poultry
Project Director
Susan Lamont
Organization
Iowa State University
Accession Number
1017001

⭐ Advanced Technologies for the Genetic Improvement of Poultry

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Poultry provides a major animal protein source for human diets. The US industry must continue to genetically improve the production stocks, and needs fundamental scientific information about the genetic control of important biological traits in order to do so.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We determined that genetic lines of chickens that are relatively more resistant or susceptible to avian influenza virus have different expression of genes related to immune function, especially the interferon pathway.

We identified that the immune cells of diverse chicken genetic lines have different metabolic capacities.

We developed a genotyping platform to analyze African chicken lines, and determined that there are multiple regions of the genome each explaining over 1% of the response to Newcastle Disease Virus (NDV). We demonstrated moderate heritabilities of several important biological traits in these chicken populations.

Briefly describe how your target audience benefited from your project's activities.

New scientific knowledge enabled other scientists to build their future studies on this information. Poultry breeding companies can use this information within their in-house programs for animal genetic improvement.

Briefly describe how the broader public benefited from your project's activities.

Future application of this information will increase efficiency in production of eggs and chicken meat, resulting in better food security and improved economics for the consumer.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Postdocs and graduate students received training in the project research. Results were disseminated in scientific journal publications: DOI: 10.5897/JVMAH2021.0912 and doi.org/10.1038/s41598-021-89306-0 and doi.org/10.3390/genes12020255.

Closing Out (end date 09/07/2023)
Enhancing Microbial Food Safety by Risk Analysis
Project Director
James Dickson
Organization
Iowa State University
Accession Number
1017551

⭐ **Enhancing Microbial Food Safety by Risk Analysis**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The Centers for Disease Control and Prevention (CDC) estimates that one in six Americans becomes sick each year from eating contaminated food, with about 48 million cases of foodborne illness, 128,000 hospitalizations, and 3,000 deaths occurring each year from foodborne pathogens in the U.S. (Scallan et al., 2011). The long-term goal of this project is to perform comprehensive and integrated risk-based research and outreach to improve the safety of food from farm to fork. Interested stakeholders, including food producers and/or processors, retailers and consumers, have identified the need for an approach that conducts applied research to determine the prevalence and ecology of foodborne pathogens (including antibiotic resistant bacteria) in fresh and processed foods coupling that to research aimed at establishing effective control methods to decrease pathogen contamination of foods. Several outreach objectives have also been developed in support of this project.

These objectives include communication of risk-based management recommendations derived from the research aspects of this proposal to stakeholders as well as to those who interact with stakeholders. Communication strategies will be precisely tailored to the particular audience (processors, distributors, retailers, consumers). Message content will focus on risk-based strategies and microbial control opportunities deemed critical for each target audience to achieve the greatest strides in improving food safety in the U.S. Outreach to those who advise producers and consumers (e.g. educators, extension

personnel) who are not part of the project will be achieved through ongoing symposia to disseminate key information concerning lessons learned during the course of this project. Iowa State University will focus primarily on foods of animal origins (meat, poultry, eggs, dairy) and identify biological hazards that are of most importance to the consumer. Intervention startegies will be developed to address these risks during harvest and further processing. These intervention startegies will be disseminated to producers and processors, and will address additional issues and concerns during implementation.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Objective 1: Risk Assessment: Characterize food safety risks in food systems Nothing to report

Objective 2. Risk Management: Develop, validate and apply science-based interventions to prevent and mitigate food safety threats.

Salmonella enterica serovar I 4,[5],12:i:- has become an organism of interest for the pork industry because of a major foodborne disease outbreak associated with roaster pigs in the northwestern United States. In 2015, an outbreak of multidrug- resistant Salmonella I 4,[5],12:i: infections was linked specifically to roaster pigs, with 134 confirmed human cases. All of the pigs were processed at the same federally inspected establishment in Washington State. The establishment was "very small," based on the U.S. Department of Agriculture, Food Safety and Inspection Service classification scheme, and although the operators were following standard industry practices, they were not using any microbial interventions. Subsequent environmental sampling revealed the specific Salmonella strain in the lairage pens of the establishment. During the investigation, the chefs cooking pigs contended that the meat was cooked to appropriate temperature, raising the possibility that the organism might have been resistant to normal pathogen reduction processes including cooking temperatures.

However, previous research findings suggest that current pork slaughter practices are effective for controlling nontyphoidal Salmonella.

A mixed culture of Salmonella enterica serovar I 4,[5],12:i:- isolates was compared with a mixed culture of reference Salmonella serovars and nonpathogenic Escherichia coli surrogates. The two groups of Salmonella were compared for their resistance to commonly used pork carcass interventions, survival in ground pork, and thermal resistance in ground pork. No differences in responses were observed between the two groups of Salmonella serovars and the nonpathogenic E. coli surrogates within intervention type. No differences in recovery and survival or in heat resistance were observed between the two groups of Salmonella serovars in pork that had been treated, ground, and stored at 58C for 2 weeks. However, the heat resistance of both groups of Salmonella serovars decreased after refrigerated storage. Because no differences were observed between Salmonella serovar I 4,[5],12:i:- and the reference Salmonella serovars in response to interventions commonly used in the pork industry, Salmonella I 4,[5],12:i:- does not present a unique challenge to the pork industry.

Objective 3: Risk Communication Nothing to report

Briefly describe how your target audience benefited from your project's activities.

The target audience is food safety professionals in the industry and regulatory agencies. The benefits of this research include the assurance that current practices are equally effective against the strain of Salmonella which has come to prominence in pork as they are with other, better known and studied Salmonella strains.

Briefly describe how the broader public benefited from your project's activities.

The general public benefits from these studies indirectly, in that the pork industry does not have to devote additional resources to controlling this one specific serotype of Salmonella and can instead focus their resources on the control of Salmonella in general. The results of this project also demonstrated that the heat resistance of Salmonella is reduced by refrigerated storage, which means that if the guidance to the public on cooking instructions is followed, then there is an additional margin of safety to the general public, as the heat resistance after storage is less.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

The project has provided professional training opportunities for undergraduate students.

Next project period we will continue your research on interventions for meat and poultry products.

⭐ Salmonella Interventions for the Pork Industry

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The Centers for Disease Control and Prevention (CDC) estimates that one in six Americans becomes sick each year from eating contaminated food, with about 48 million cases of foodborne illness, 128,000 hospitalizations, and 3,000 deaths occurring each year from foodborne pathogens in the U.S. (Scallan et al., 2011). The long-term goal of this project is to perform comprehensive and integrated risk-based research and outreach to improve the safety of food from farm to fork. Interested stakeholders, including food producers and/or processors, retailers and consumers, have identified the need for an approach that conducts applied research to determine the prevalence and ecology of foodborne pathogens (including antibiotic-resistant bacteria) in fresh and processed foods coupling that to research aimed at establishing effective control methods to decrease pathogen contamination of foods. Several outreach objectives have also been developed in support of this project. These objectives include communication of risk-based management recommendations derived from the research aspects of this proposal to stakeholders as well as to those who interact with stakeholders. Communication strategies will be precisely tailored to the particular audience (processors, distributors, retailers, consumers). Message content will focus on risk-based strategies and microbial control opportunities deemed critical for each target audience to achieve the greatest strides in improving food safety in the U.S. Outreach to those who advise producers and consumers (e.g., educators, extension personnel) who are not part of the project will be achieved through ongoing symposia to disseminate key information concerning lessons learned during the course of this project. Iowa State University will focus primarily on foods of animal origins (meat, poultry, eggs, dairy) and identify biological hazards that are of most importance to the consumer. Intervention strategies will be developed to address these risks during harvest and further processing. These intervention strategies will be disseminated to producers and processors and will address additional issues and concerns during implementation.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Objective 1: Risk Assessment: Characterize food safety risks in food systems Nothing to report

Objective 2. Risk Management: Develop, validate and apply science-based interventions to prevent and mitigate food safety threats.
Salmonella enterica serovar I 4,[5],12:i:- has become an organism of interest for the pork industry because of a major foodborne disease outbreak associated with roaster pigs in the northwestern United States. In 2015, an outbreak of multidrug-resistant Salmonella I 4,[5],12:i: infections was linked specifically to roaster pigs, with 134 confirmed human cases. All of the pigs were processed at the same federally inspected establishment in Washington State. The establishment was "very small," based on the U.S. Department of Agriculture, Food Safety and Inspection Service classification scheme, and although the operators were following standard industry practices, they were not using any microbial interventions. Subsequent environmental sampling revealed the specific Salmonella strain in the lairage pens of the establishment. During the investigation, the chefs cooking pigs contended that the meat was cooked to the appropriate temperature, raising the possibility that the organism might have been resistant to normal pathogen reduction processes, including cooking temperatures.

However, previous research findings suggest that current pork slaughter practices are effective for controlling nontyphoidal Salmonella.

A mixed culture of Salmonella enterica serovar I 4,[5],12:i:- isolates was compared with a mixed culture of reference Salmonella serovars and nonpathogenic Escherichia coli surrogates. The two groups of Salmonella were compared for their resistance to commonly used pork carcass interventions, survival in ground pork, and thermal resistance in ground pork. No differences in responses were observed between the two groups of Salmonella serovars and the nonpathogenic E. coli surrogates within intervention type. No differences in recovery and survival or in heat resistance were observed between the two groups of Salmonella serovars in pork that had been treated, ground, and stored at 58C for two weeks. However, the heat resistance of both groups of Salmonella serovars decreased after refrigerated storage. Because no differences were observed

between Salmonella serovar I 4,[5],12:i:- and the reference Salmonella serovars in response to interventions commonly used in the pork industry, Salmonella I 4,[5],12:i:- does not present a unique challenge to the pork industry.

Briefly describe how your target audience benefited from your project's activities.

The target audience is food safety professionals in the industry and regulatory agencies. The benefits of this research include the assurance that current practices are equally effective against the strain of Salmonella which has come to prominence in pork as they are with other, better known and studied Salmonella strains.

Briefly describe how the broader public benefited from your project's activities.

The general public benefits from these studies indirectly, in that the pork industry does not have to devote additional resources to controlling this one specific serotype of Salmonella and can instead focus their resources on the control of Salmonella in general. The results of this project also demonstrated that the heat resistance of Salmonella is reduced by refrigerated storage, which means that if the guidance to the public on cooking instructions is followed, then there is an additional margin of safety to the general public, as the heat resistance after storage is less.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

The project has provided professional training opportunities for undergraduate students.

Next project period, we will continue our research on interventions for meat and poultry products.

Interaction of cropping systems with their environment in the central United States
Project Director
Andy VanLoocke
Organization
Iowa State University
Accession Number
1013106

⭐ **Objective 2 - Bioenergy Grasses**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Bioenergy grasses provide a potential option for land managers and energy producers in the Central US. Two examples include the high yielding grasses, biomass sorghum and miscanthus. Little is known about the changes that would occur to agro-ecosystems and the surrounding waters and atmosphere if they were to be adopted at a large scale.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We conducted a large-scale field experiment aimed at identifying the changes to the soil, water and atmosphere that are associated with bioenergy grasses. At a 60-acre field site near the campus of Iowa State University and a sister experiment that has three ~10 acre locations spread across Iowa, we collected data on biomass sorghum and miscanthus under different management conditions. Data collection included sensors that monitor the exchange of carbon, water, and energy between crop canopies and the atmosphere. We also monitored soil moisture and temperature as well as subsurface drainage. Crop productivity was also monitored using a combination of ground-based and remotely sensed methods.

Analysis of data collected thus far indicates that miscanthus had the largest carbon uptake followed by corn and biomass sorghum, similar to soybeans. We found a similar pattern in water use among the four crops. We also found that when it is first planted (i.d., established) miscanthus may lose similar amounts of nutrients in subsurface water compared to corn. However, as it becomes established, nutrient losses tended to decrease. More data were collected during this FY and will be analyzed in the subsequent reporting period.

We also used the data collected in this project to update the agro-ecosystem model Agro-IBIS. Two major updates were completed in this FY. First, we added the ability to simulate biomass sorghum to the model by adapting existing corn crop simulation modules and comparing the results to the data collected at our field sites. Second, we developed a workflow that allowed for biomass and water quality simulation results to be linked to an economic model named BEPAM. We used the new biomass sorghum module to estimate the productivity and potential ethanol production of that bioenergy grass compared to the existing option of corn-based ethanol production. We used the improved economic modeling capacity to investigate how the renewable fuels standard might impact land use and water quality in the Mississippi River Basin.

Our modeling simulations indicated that biomass sorghum productivity and ethanol production will compare differently to corn as you move from southern to northern Iowa. In the south, biomass sorghum is likely to produce similar or larger amounts compared to corn, whereas that difference starts to favor corn as you move to central and northern Iowa. In the economic modeling, we found that miscanthus production to meet the renewable fuels standard cellulosic production targets would likely occur largely outside of the corn belt region of the Mississippi River Basin, largely due to economic favorability of corn and soybeans relative to miscanthus, this lead to relatively small changes in potential water quality associated with the policy. If we changed the simulated policy in the BEPAM economic model to only allow for perennial biomass crops, that increased the adoption of miscanthus in the high nutrient loss areas of the corn belt, but still had a minimal impact. Subsequent work will examine the impact of economically valuing water quality as a monetized externality in the BEPAM model.

To understand how economic and agronomic factors have impacted historical land use changes, we also studied maps of farm-scale land use produced by the USDA. These satellite-based products can indicate the type of crops or other vegetation used on the land and when studied in different years, can indicate when land use has changed. We focused our analysis on a highly sloped region known as the Driftless region, in the central corn belt that was not smoothed by glaciers like much of the surrounding flatter terrain.

We found that many areas within the Driftless region had major changes in land use over the ten-year period proceeding our analysis year. Land that was formerly in alfalfa, grasses and small grains was converted to corn and soybeans. We also found that some of the highest sloped watersheds had the largest proportion of change. Finally, an analysis of dairy production statistics indicated that dairy production decreased and consolidated, consistent with the change of land from grasses and alfalfa, which are typically used to support nearby dairy cattle, to corn and soybeans, which are typically used in more diffuse downstream pathways and farther-reaching geographies.

Briefly describe how your target audience benefited from your project's activities.

Our target audience of land managers and policy makers will benefit from the new information we gathered on the performance of different cropping systems in farmed potholes. Our data can provide the basis for land managers to inform them about land use in their surrounding areas, which may impact their choices locally. Policy makers can use our information to understand the implications of existing policies that incentivize certain land uses as well as future policies that might have different incentives for land use.

Briefly describe how the broader public benefited from your project's activities.

The general public will benefit from these activities through increased access to information about historical and potential land uses. Knowing more about the historical land use shifts may help increase awareness around the impact of various policies and consumer choices on what type of crops are being grown in their region. The observations of carbon uptake and water quality impacts of bioenergy grasses and be helpful for the general public as I may lead to policies that help incentives practices that increase carbon uptake and decrease nutrient losses. Increasing carbon uptake by agroecosystems can help reduce the rate of greenhouse gas accumulation as well as improve the productivity of soils. Improved water quality would help make the water safer to drink and less expensive to treat prior to consumption.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to

communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Several graduate and under graduate students gained professional and specialized training via participation in the is project. In addition multiple professional and scientific staff members gained additional experience and training in their field including professional development activities. Examples include Campbell Scientific data logger programing training courses, teaching via guest lectures in the course Agronomy 183, "Basic skills for agronomists" and outreach events.

Our results have been disseminated through presentations to the scientific community, public presentations and peer reviewed publications (see below).

Edmonds, P., Franz, K. J., Heaton, E. A., Kaleita, A. L., Soupir, M. L., & VanLoocke, A. (2021). Planting miscanthus instead of row crops may increase the productivity and economic performance of farmed potholes. *GCB Bioenergy*, *13*(9), 1481-1497.

Bendorf, J., Hubbard, S., Kucharik, C. J., & VanLoocke, A. (2021). Rapid changes in agricultural land use and hydrology in the Driftless Region. *Agrosystems, Geosciences & Environment*, *4*(4).

Studt, J. E., McDaniel, M. D., Tejera, M. D., VanLoocke, A., Howe, A., & Heaton, E. A. (2021). Soil net nitrogen mineralization and leaching under Miscanthus× giganteus and Zea mays. *GCB Bioenergy*, *13*(9), 1545-1560.

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Ferin, K., Balson, T., Liess, S., Ward, A. S., Twine, T. E., & VanLoocke, A. (2020, December). The Impact of Climate Variability and Land Management Practices on Water Quality in Iowa at the Watershed Scale. In *AGU Fall Meeting Abstracts* (Vol. 2020, pp. H058-0004).

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Critical Issue

Health, Nutrition and Well-being

EFNEP and SNAP-Ed Nutrition Education and Healthy Food Access Programs

Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001462

⭐ **EFNEP and SNAP-Ed Nutrition Education and Healthy Food Access Programs**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Quality nutrition and active living support chronic disease prevention, stress management and overall wellbeing. Iowans with low income may experience unique challenges to eating well and staying active. EFNEP and SNAP-Ed programs provide a complementary approach to addressing this challenge. EFNEP focuses on direct education prioritizing youth and caregivers while SNAP-Ed serves a wider audience and includes interventions in policy, systems and environments to make healthy choices easier. Synergistically, the programs complement one another without duplication.

- **Fruit and Vegetables**: Dietary Guidelines for Americans (2020) recommend 1.5-2 cups of fruit per day and 2-3 cups of vegetables (approximately 5 servings/day).
  - According to the United Health Foundation's Health Rankings (2019), 7.1% of Iowans consume five servings of fruits and vegetables per day. Iowans in the lowest income category consume even less with only 6.1% of Iowans earning less than $25,000 per year meeting recommendations.

- The 2018 Iowa Youth Survey (IYS) data show that 53% of 6th graders ate green salad, carrots, potatoes or other vegetables one time or less per day. The 2018 IYS data show that 16% of 6th graders statewide consumed fruit less than one time per day. 50% consumed fruit one or two times per day.

- **Physical Activity**: The 2018 Physical Activity Guidelines for Americans recommend that adults participate in 150 minutes of activity per week and children have 60 minutes of active play per day.
  - The 2016 Behavioral Risk Factor Surveillance System data show that 35.9% of adult Iowans in the lowest household income category engage in no leisure time physical activity. Only 12.7% of those with the highest income report no leisure time activity.

  - The 2018 IYS data show that 25% of 6th grade youth in Iowa indicate being active for 60 minutes per day over the past week.

- **Food Safety**: According to the Centers for Disease Control, 1 in 6 Americans become ill from eating contaminated food each year.
  - Previous EFNEP and SNAP-Ed data show that many families do not, seldom, or sometimes (as opposed to most of the time or almost always) practice food safety management skills such as thawing and storing food properly.

- **Food Resource Management and Access**: Food insecurity contributes to health problems, especially when people are choosing between food and stable housing, transportation or medicine. Children who experience food insecurity are more likely to repeat a grade in school, experience learning or language delays, and have behavioral or emotional problems.
  - 1 in 9 Iowans are food insecure.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Quality nutrition and active living support chronic disease prevention, stress management and wellbeing. Iowans with low income may have unique challenges to eating well and staying active. EFNEP and SNAP-Ed programs provide a complementary approach to addressing this challenge. EFNEP focuses on direct education prioritizing youth and caregivers while SNAP-Ed serves a wider audience and includes interventions in policy, systems and environments to make healthy choices easier. Synergistically, the programs complement one another without duplication. Program results reflect a multi-faceted approach to making healthy choices easier through changes in knowledge, behavior and access. Participants build knowledge of nutrition and develop skills related to food safety and food resource management. Gardening partnerships boost produce access in food pantries. When combined, these elements help Iowa families establish and maintain healthy habits even when budgets are tight.

Program participants meet income eligibility guidelines (185% of the federal poverty level). On average, 50-55% of program participants have identified with an underserved race or ethnicity. The majority of program participants are women. Most service has been in communities with a population above 10,000 people. Youth programs focus on children in grades K-5 and the majority of youth service has been in an urban setting.

SNAP-Ed and EFNEP programming reached 730 adults via 5,228 direct education sessions in 14 counties. SNAP-Ed healthy food access projects reached more than 65,000 Iowans at 119 food pantries with policy, system and environmental change initiatives in 33 counties. Staff consist of 27 Human Sciences Extension staff, including 16 paraprofessional peer educators. Additionally, 267 Master Gardener volunteers contributed time to support healthy food access initiatives.

Three curricula feature content for participants with different needs and experience.

- **Kids in the Kitchen** empowers children to make healthy choices through cooking. Children try new foods in a fun and supportive environment and learn to make healthy dishes they enjoy while staying safe in the kitchen.

- **Buy. Eat. Live Healthy** participants build their knowledge of basic nutrition and establishing healthy habits while cooking together and practicing money saving strategies to stretch their food dollar.

- **Plan Shop Save and Cook** participants learn and practice the skills needed to eat well on a budget.
Additional initiatives make healthy choices easier.

  - **Growing Together Iowa** partners with community food pantries across the state to create donation gardens as hyper-local answer to food access challenges.

  - **The Spend Smart. Eat Smart**. website wraps around all programming to offer 24-hour access to resources that make healthy choices easier. Recipes, videos, meal planning tools and more give Iowans support in their efforts to establish healthy habits.

Briefly describe how your target audience benefited from your project's activities.

Measure #1: Percent of youth and adult participants reporting increased intake of fruits and vegetables.

Youth increase their frequency of vegetable consumption = 33%

Youth increase their frequecy of fruit consumption = 38%

Adults increase their frequency of vegetable consumption = 46%

Adults increase their frequecy of fruit consumption = 30%

Measure #2: Percent of youth and adult participants reporting increased physical activity.

Youth activity = 42%

Adult activity = 55%

Measure #3: Percent of adult participants reporting increased food safety skills

Adults increased food safety skills = 74%

Measure #4: Percent of adult participants reporting increased food resource management skills

Adults report increased food resource managment skills = 88%

Adults report food security = 11%

Measure #5: Number of pounds of produce donated to the Iowa food pantry system

Pounds of produce donated to food pantries = 91,772

Briefly describe how the broader public benefited from your project's activities.

It is anticipated the broader public benefits from participants engaging in the EFNEP and SNAP-Ed programs by youth and adult participants improving their diet, physical activity, food resource management, food safety, and food security. In turn, these changes can benefit the broader public by decreasing medical care demands and increasing the avilability of medical staff. Additionally, the changes can decrease the number of days employees call in sick from work or need to take their children out of school due to illness.

Servsafe® Food Protection Manager Certification
Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001460

ServSafe - Outcomes Report

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

It is estimated that 48 million people experience a foodborne illness each year with 3,000 deaths resulting from foodborne illness (CDC, 2011). Providing food handlers and decision makers involved in food preparation and service with knowledge about food safety risks and ways to mitigate the risks can help in reducing incidents of foodborne illness and protecting public health. Servsafe® is a food safety training program developed by the National Restaurant Association and has been used for a number of years across the United States.

CDC (2011). Burden of Foodborne Illness: Findings. https://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In Iowa, ten Food and Health Field Specialists conducted the workshops and training occurred in all 27 regions of the state. Eight-hour Servsafe® workshops were presented on safe food handling practices. This training was provided to participants from across Iowa. In 2021, 2,033 Iowans participated in an 8-hour Servsafe® workshop on safe food handling practices.

Increase in knowledge about food safety and safe food handling practices.

- **76.5%** (n=1,555) of all participants (n=2,033) increased knowledge about food safety and safe food handling procedures as indicated by obtaining a score of at least 75% on a post-course assessment for certification.

Briefly describe how your target audience benefited from your project's activities.

This training educates food service workers about food safety guidelines that are recommended by the FDA Food Code. The training helps food service workers to learn how to safely handle food and achieve professional certification through the National Restaurant Association.

Briefly describe how the broader public benefited from your project's activities.

This training educates food service workers about food safety guidelines that are recommended by the FDA Food Code. By training food-service workers to learn how to safely handle food, Iowa consumers are protected from getting food poisoning, preventing potentially serious illness or death.

Biology, Ecology & Management of Emerging Disease Vectors
Project Director
Ryan Smith
Organization
Iowa State University
Accession Number
1020452

⭐ **Mosquito and tick surveillance**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

We conducted mosquito and tick surveillance in the state of Iowa to better understand the abundance and ecology of these arthropod vectors and the diseases that they transmit. When paired with the long-term data set of surveillance efforts from previous years, these data provide valuable insight into vector ecology and vector-borne disease transmission.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

A primary goal of our mosquito surveillance efforts has been to monitor the abundance of *Culex* species to better understand the transmission of West Nile virus (WNV) in the state of Iowa. In 2021, surveillance efforts were performed in 7 Iowa counties, resulting in record numbers of Culex species and high levels of WNV in mosquito populations as determined by testing

mosquito pools through cooperative efforts with the State Hygienic Lab. Despite the high level of WNV activity, very few human cases were reported. Continued efforts are focused on trying to further understand WNV transmission dynamics in the state.

In addition, we have continued to monitor populations of the invasive mosquito *Aedes albopictus*. In 2021, we performed surveillance efforts in 10 Iowa counties, finding these invasive species in 3 counties. These data provide strong support for the overwintering and establishment of this species. These findings describing our cumulative efforts since 2016 were posted as a pre-print (https://doi.org/10.1101/2021.10.20.465182) and have been submitted for publication.

We also performed active and passive surveillance efforts to examine tick populations in the state in 2021, collecting more than 500 individual tick samples. As in previous years, a primary focus of our efforts was to better understand the range of deer tick (*Ix. scapularis*) populations in the state. For the year, we were able to establish deer tick populations in 6 new Iowa counties.

Briefly describe how your target audience benefited from your project's activities.

In addition to generating reports for local and state public health officials, mosquito and tick surveillance results have been disseminated through local, regional, and national databases to serve the greater community of public health professionals, mosquito control professionals, and academic researchers interested in medical entomology and disease ecology. Results have also been shared with other members of the Upper Midwest Center of Excellence in Vector Borne Disease, initiating conversations of vector-borne disease surveillance outside of traditional state borders. Dissemination of these findings has also been shared through presenting results at scientific meetings, in media, and in timely scientific publications.

Briefly describe how the broader public benefited from your project's activities.

The results of this project directly benefit the citizens of Iowa, informing public health decisions at the county- and state-wide levels. Not only do these data inform these decisions for the current season, but when paired with previous years data, can greatly inform trends in vector abundance and vector-borne disease transmission in the future.

Closing Out (end date 09/07/2023)
Nutrient Bioavailability--Phytonutrients and Beyond
Project Director
Wendy White
Organization
Iowa State University
Accession Number
1018896

⭐ **Nutrient Bioavailability--Phytonutrients and Beyond**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

About 38 percent of Ugandan children under 5 years old are clinically deficient in vitamin A. Vitamin A is needed to support the immune system. Children who are deficient have a higher risk of dying from infectious diseases such as diarrhea or measles. Advanced vitamin A deficiency causes vision loss and worldwide is the leading cause of preventable childhood blindness. Researchers at Queensland University of Technology, Brisbane, Australia used genetic modification to develop bananas with enhanced content of pro-vitamin A. The pro-vitamin A bananas are intended to benefit Ugandan communities where vitamin A deficiency is widespread and bananas are an important part of the diet. In conventional dietary pro-vitamin A sources, such as carrots and spinach, a fraction of the pro-vitamin A is available to be absorbed and converted to vitamin A by the human body. Thus an evaluation of the bioavailability of the pro-vitamin A in the nutritionally-enhanced bananas was needed. This project determined the extent to which the pro-vitamin A contents in the bananas were available to be absorbed and converted to vitamin A when eaten. A total of 12 study participants each consumed three single servings of bananas: 1) provitamin-A bananas; 2) conventional bananas with a known amount of added beta-carotene; and 3) conventional bananas with a known amount of added vitamin A. Blood samples were collected at selected time points for analysis of the intact pro-vitamin A and converted vitamin A absorbed after each banana serving was consumed.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Previously, we developed an ultra high-sensitivity HPLC-high-resolution mass spectrometric (HPLC-HRMS) method to enable quantification of the minute amounts of intact pro-vitamin A and vitamin A absorbed after consumption of a single serving of bananas. The method was used in the current project to analyze plasma fractions of the blood samples collected from our research participants at each time point. For each participant, a quantitative comparison of the areas under the absorption curves (AUCs) was then used to calculate the efficiency of the conversion of the consumed pro-vitamin A in the bananas to vitamin A. Thus we determined the average vitamin A contribution of the pro-vitamin A consumed in the bananas.

Briefly describe how your target audience benefited from your project's activities.

Our findings indicate that the pro-vitamin A in the bananas has good bioavailability to be converted to vitamin A. The results of this project support the ongoing development of the bananas and inform their target provitamin A content and the design of community field trials.

Briefly describe how the broader public benefited from your project's activities.

Our study found good bioavailability of the pro-vitamin A in the bananas and thus addressed an important potential feasibility constraint in their development. Our findings indicate the pro-vitamin A bananas are a promising dietary intervention to alleviate vitamin A deficiency in banana-consuming communities in East Africa.

Personal Protective Technologies for Current and Emerging Occupational and Environmental Hazards

Project Director

Chunhui Xiang

Organization

Iowa State University

Accession Number

1014102

⭐ Personal Protective Technologies for Current and Emerging Occupational and Environmental Hazard

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Among the estimated two million agricultural workers in the United States, physicians diagnose 10,000 to 20,000 pesticide poisonings each year. The National Institute for Occupational Safety and Health (NIOSH) established the Sentinel Event Notification System for Occupational Risks – Pesticides Program (SENSOR-Pesticides) in 1987 to reduce the number of injuries and illnesses associated with occupational pesticide exposure. A total of 2,606 cases of acute occupational pesticide-related illness and injury were identified in 12 states from 2007-to 2011. The number of pesticide-related illnesses reported in Iowa in 1998-to 2011 showed that rates of illness and injury among agricultural industry workers (18.6/100,000) were 37 times greater than the rates for nonagricultural workers (0.5/100,000). In 2013, approximately 2 million exposures were reported to U.S. poison control centers, approximately 3% were attributed to acute exposures to pesticides. Pesticides were the seventh most frequent category of poison exposures in persons aged ≥20 years. Those exposures resulted in 13,313 minor health outcomes, 2,095 major and moderate health outcomes, and 22 deaths.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Exposure to pesticides under conditions of inappropriate use or insufficient protection can cause a wide range of health effects. Typical examples include: (1) The clothes used for pesticide application were washed together with the family laundry, and (2) Storing pesticides inside the home. It is impossible to know when the contamination occurs as there is no warning system. In the NIOSH 2007-2011 report, most affected persons were exposed to insecticides or herbicides. Among persons exposed to insecticides, the chemical classes most often involved were pyrethroids, organophosphates, sulfur compounds, and pyrethrins. Organophosphates (OPs), nerve agents, are a class of lethal weapons of mass destruction that kill by disrupting the nerve transfer mechanism. Unfortunately, these highly adhesive and volatile nerve agents are colorless, odorless and tasteless, making detection very difficult. Therefore, a reliable nerve agent detection system is critically desirable in the current climate of terrorism awareness. Conventional analytical methods such as gas chromatography and

mass spectroscopy are still considered to be the most reliable techniques despite the recent development of sensors based on ?uorescence, carbon nanotubes, microcantilever, and liquid crystals. The conventional analytical detection systems, however, require expensive equipment that is often not portable due to weight and size and is only operable by well-trained personnel. Therefore, a simple and rapid yet reliable detection system is highly desirable. Particularly, equipment-free sensor systems such as colorimetric detection by the naked eye would be among the best and most practically useful methods.

In order to address the challenges, we developed novel nanofiber-based sensors to detect the pesticides for chemical protective clothing. Our initial effort focused on the colorimetric change that can be easily detected by the naked eye. The nanofiber-based sensors are lightweight and strong, and can be tailored to detect pesticides. In addition, nanofiber-based sensors have a large surface area and 3D nanofiber network, which can increase the potential number of molecules that can react of pesticides and also enhance the roughness of the substrate's surface to increase sensitivity.

Briefly describe how your target audience benefited from your project's activities.

The developed novel nanofiber-based sensors will be used to detect pesticides for chemical protective clothing. This research addresses the urgent need of safety protection for farmers and personnel working in hazardous environment, including firefighters and soldiers.

Briefly describe how the broader public benefited from your project's activities.

This research addresses the urgent need of safety protection for farmers and personnel working in hazardous environment, including firefighters and soldiers. The project will advance the health and well-being of farmers, and science and technology in the human environment.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Publication:

Alam, AKM, Mashud, Jenks, Donovan, Kraus, George, †Xiang, Chunhui. (2021) Synthesis, Fabrication, and Characterization of Functionalized Polydiacetylene Containing Cellulose Nanofibrous Composites for Colorimetric Sensing of Organophosphate Compounds. *Nanomaterials*, 2021. 11(8): p. 1869.

Improving Human Foods: Functionality, Selection, and Nutrition
Project Director
James Hollis
Organization
Iowa State University
Accession Number
1013112

⭐ **Improving Human Foods: Functionality, Selection, and Nutrition**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Chronic disease has significant personal, social and economic consequences for the US population. Reducing the number of people with chronic disease is a leading public health goal. Data indicate that a poor diet is a major contributor to many chronic disease states and this project is conducting research to understand the link between diet and disease and to develop interventions to improve dietary habits.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Studies, using cell and animal models and humans, have been conducted to better understand how food properties influence human health. In addition, projects that have developed interventions to improve human health and reduce the risk of chronic disease (e.g., type 2 diabetes, obesity, Parkinson's disease) have been completed. These studies have used cell and animal models as well as humans. The results from these studies were disseminated through presentations at national and international conferences, peer-reviewed publications, and extension/outreach.

This project has provided new knowledge regarding the link between diet and disease and has contributed to new approaches to reduce the number of people with chronic disease. Through collaboration with food companies, another key impact of this research was the development of foods that improve human health and open new markets for producers.

Briefly describe how your target audience benefited from your project's activities.

Results have been disseminated through publications in scientific journals, presentations at professional conferences, presentations at extension meetings, and published abstracts. Moreover, a diabetes education program has been tested in Latino populations. The feasibility of an intervention in schools has also been tested. These interventions may contribute to community efforts to improve diet. New appraoches to understand consumer behavior, using immersive virtual reality, have been developed and tested. New sources of dietary iron have been investigated to reduce the burden of iron-deficiency anemia. In addition, new processing approaches for processing milks and developing emulsions that aid the creation of healthier food products have been investigated and the results communicated to industry partners.

Briefly describe how the broader public benefited from your project's activities.

Changing dietary habits is key to reducing chronic disease risk and improving health. This work has contributed to the developemnt of healthier processed foods, the development of community interventions to improve diet in children and latinos, the identification of barriers to eating pulses and legumes and the development of novel methods for understanding consumer behavior. This work has contributed to efforts to improve the food supply to improve health among the general public.

⭐ Improving Human Foods: Functionality, Selection, and Nutrition

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Chronic disease has significant personal, social, and economic consequences for the US population. Reducing the number of people with chronic disease is a leading public health goal. Data indicate that a poor diet is a major contributor to many chronic disease states, and this project is conducting research to understand the link between diet and disease and to develop interventions to improve dietary habits.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Studies using cell and animal models and humans have been conducted to better understand how food properties influence human health. In addition, projects that have developed interventions to improve human health and reduce the risk of chronic disease (e.g., type 2 diabetes, obesity, Parkinson's disease) have been completed. These studies have used cell and animal models as well as humans. The results from these studies were disseminated through presentations at national and international conferences, peer-reviewed publications, and extension/outreach.

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Results have been disseminated through publications in scientific journals, presentations at professional conferences, presentations at extension meetings, and published abstracts. Moreover, a diabetes education program has been tested in Latino populations. The feasibility of an intervention in schools has also been tested. These interventions may contribute to

community e?orts to improve diet. New approaches to understand consumer behavior, using immersive virtual reality, have been developed and tested. New sources of dietary iron have been investigated to reduce the burden of iron-deficiency anemia. In addition, new processing approaches for processing milks and developing emulsions that aid the creation of healthier food products have been investigated and the results communicated to industry partners.

Briefly describe how the broader public benefited from your project's activities.

Changing dietary habits is key to reducing chronic disease risk and improving health. This work has contributed to the development of healthier processed foods, the development of community interventions to improve diet in children and Latinos, the identification of barriers to eating pulses and legumes, and the development of novel methods for understanding consumer behavior. This work has contributed to e?orts to improve the food supply to improve health among the general public.

Critical Issue

Human Potential and Youth Development

Essentials to Child Care

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7001439

Essentials to Child Care - Outcomes Report

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Child Care workforce turnover is reported at 35-55% annually and has contributed to a 33% loss of Iowa child care programs over the last five years. Programs remaining open continually struggle to recruit new child care providers and teachers. New staff typically have limited training and education helping them to be successful in their new role. The Essentials to Child Care Program offers 12 online classes to help staff quickly learn and build confidence in their work with children.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

68,525 total class certificates of completion were issued to Iowa early childhood teachers and providers for successfully completing at least one of the 12 offered online classes in the Essentials to Child Care Program. Participants completing each online class were required to successfully attain a minimum score of 80% accuracy on a knowledge- based quiz and identify at least one planned change or improvement in practice.

Increased knowledge on how to create safe environments for young children

- 100% of participants (n = 6,154) increased knowledge on how to create safe environments for young children as measured on a post-course certification exam.

Increased knowledge on emergency preparation

- 100% of participants (n = 6,697) increased knowledge on emergency preparation as measured on a post-course certification exam.

Increased knowledge on how to transport children safely

- 100% of participants (n = 5,978) increased knowledge on how to transport children safely as measured on a post-course certification exam.

Increased knowledge on prevention and control of infectious disease

- 100% of participants (n = 5,959) increased knowledge on prevention and control of infectious disease as measured on a post-course certification exam.

Increased knowledge on reducing hazardous materials

- 100% of participants (n = 5,699) increased knowledge on reducing hazardous materials as measured on a post-course certification exam.

Increased knowledge on medication management for children in child care

- 100% of participants (n = 5,528) increased knowledge on medication management for children in child care as measured on a post-course certification exam.

Increased knowledge on preventing and managing food allergy reactions with young children

- 100% of participants (n = 5,568) increased knowledge on preventing and managing food allergy reactions with young children as measured on a post-course certification exam.

Increased knowledge on infant safe sleep and the prevention of Sudden Infant Death Syndrome

- 100% of participants (n = 5,421) increased knowledge on infant safe sleep and the prevention of Sudden Infant Death Syndrome as measured on a post-course certification exam.

Increased knowledge on Prevention of Shaken Baby Syndrome

- 100% of participants (n = 5,462) increased knowledge on prevention of Shaken Baby Syndrome as measured on a post-course certification exam.

Increased knowledge on Supporting Cultural Diversity

- 100% of participants (n = 5,427) increased knowledge on supporting cultural diversity as measured on a post-course certification exam.

Increased knowledge on Understanding Homelessness

- 100% of participants (n = 5,376) increased knowledge on understanding homelessness as measured on a post-course certification exam.

Increased knowledge on Child Development

- 100% of participants (n = 5,256) increased knowledge on child development as measured on a post-course certification exam.

Briefly describe how your target audience benefited from your project's activities.

Participation in the Essentials to Child Care Program has been added to state licensing requirements for all Iowa child care teaches and providers. Child care providers who complete certification through this course benefit from accreditation in their field, competence in skills related to their profession of providing for children, and the confidence to successfully complete their work.

Briefly describe how the broader public benefited from your project's activities.

ISU Extension and Outreach's Essentials Child Care Preservice program provides child care teachers and providers with vital information on health and safety practices which leads to safer child care environments and improved health outcomes for young children. In turn, this benefits families and employers by reducing employee leave and creating a more stable workforce for Iowa communities.

Iowa Mental Health Education Program

Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001461

⭐ Iowa Mental Health Education Program - Outcomes Report

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

According to the National Alliance on Mental Illness (NAMI), 42.2% of Iowa adults reported symptoms of anxiety or depression (NAMI, 2021). In Iowa, 154,000 adults did not receive needed mental health care and 29.3% reported this was realted to cost of services. Similarly, 58.1% of Iowa youth aged 12-17 who had depression did not receive any care in the last year.

National Alliance on Mental Health (2021). Mental Health in Iowa. https://nami.org/NAMI/media/NAMI-Media/StateFactSheets/IowaStateFactSheet.pdf

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Eleven Human Sciences and Agriculture and Natural Resources Extension program specialists facilitated Mental Health First Aid (MHFA), reaching 295 participants in 22 statewide (and national) virtual workshops. Each workshop included 6-hours of instructor led education, and 2-hours of virtual pre-work.

Seven Human Sciences program specialists and one county extension educator facilitated Question.Persuade.Refer. (QPR), educating a total of 224 participants: 196 participants in 19 statewide 1-hour virtual workshops and 27 participants in one in-person workshop.

Increase participants' knowledge and confidence about how to ask individuals about whether they are considering suicide.

- **70.12%** of individuals (n=251) of QPR rated as "high" their knowledge and confidence about how to ask individuals whether they are considering suicide as measured on a post-course assessment;

- **87.84%** of participants of MHFA (n=148) "agreed" or "strongly agreed" that they feel more confident to ask anyone directylw whether they are considering killing themselves as measured on a post-course assessment.

Increase participants' knowledge of local resources, such as mental health professionals, and the likelihood it will assist a person to get help.

- **59.20%** of participants in QPR (n=250) rated as "high" their knowledge of local resources for help with suicide as measured on a post-course assessment;

- **90.67%** of participants in MHFA (n=153) indicated it was "likely" or "extremely likely" that sharing knowledge of local resources would help with suicide prevention as measured on a post-course assessment

Increase participants' knowledge and confidence in using action plans to refer an individual in crisis, or who may be suicidal, to appropriate professional resources.

- **68.38%** of participants in QPR (n=253) indicated increased knowledge and confidence in using action plans to refer an individual in crisis, or who may be suicidal, to appropriate professional resources, as measured on a post-course assessment;

- **65.33%** of participants in MHFA (n=150) indicated increased knowledge and confidence in using action plans to refer an individual in crisis, or who may be suicidal, to appropriate professional resources, as measured on a post-course assessment

Briefly describe how your target audience benefited from your project's activities.

Iowa State University Extension and Outreach's implementation of the evidence-based Mental Health First Aid and Questions.Persuade.Refer programs provide Iowans with critical information related to risk factors and warning signs of potential suicide. It teaches Iowans about mental health and substance use concerns. As a result, participants are better prepared to engage in action to intervene and assist others before a mental health crisis leads to injury or death.

Briefly describe how the broader public benefited from your project's activities.

Through improved understanding of mental health intervention, participants are prepared to help one another through life issues such as anxiety and depression. For the broader public, this results in strengthened community bonds through personal interaction with one another, reduction in health costs attributable to mental health crises, and prevention of loss of life due to suicide.

Mindful Teen
Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001766

Mindful Teen

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The 4-H Youth Mental Health Survey administered by the National 4-H Council in 2020 reported that 82% of youth wished America would talk more openly about mental health (National 4-H Council, 2020). Also in 2020, a Center for Disease Control and Prevention study indicated rates of suicide among youth and young adults ages 10-24 increased 57.4% between 2007-2018 (Curtin, 2020). Stress can also increase participation in risky, unhealthy behaviors. Research shows daily mindfulness practices can have a significantly positive impact on a person's overall health and wellness, including mental and physical health (Creswell, 2017).

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Mindful Teen: From Surviving to THRIVING! Is a six-session curriculum based on the book, *The Mindful Teen: Powerful Skills to Help You Handle Stress One Moment at a Time* by Dr. Dzung Vo (2015). The curriculum helps youth foster mindfulness skill development, thoughtful reflection, and aims to reduce stress and risk of mental illness. Throughout the six sessions, participants take part in small group or large group discussions and practice a variety of mindfulness techniques from the Mindful Teen book and coresponding journal. The Mindful Teen program was implemented in Iowa with 691 youth in 14 counties. 175 Extension staff, volunteers, and school and community partners facilitaed the sessions.

Briefly describe how your target audience benefited from your project's activities.

Ninety-six youth participants completed a post-program evaluation. After completing the sessions, 70% of the youth indicated they "Strongly Agree or Agree" they have a better understanding of how stress impacts their mental and physical state. Over 65% of respondents said they "Strongly Agree or Agree" that mindfulness practices can help them create and maintain positive relationships with people. 62% of youth reported that mindfulness practices can help their overall well-being. As a result of engaging in Mindful Teen, 67% of post-program survey respondents stated the 4-H Mindful Teen program provides tools so they can better cope with stress and difficult emotions.

Briefly describe how the broader public benefited from your project's activities.

Youth who engage in the Mindful Teen program indicate they have effective strategies to cope with stress and possess new strategies to address emotional highs and lows. In turn, it is anticipated the broader public will benefit from youth engaging in the Mindful Teen program due to youth being able to self-regulate their physcal and emotional reactions to stress and potentially decrease the level of adult intervention and medical assistance needed during stressful periods of youths' lives.

Volunteer Income Tax Assistance (VITA)
Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001463

⭐ VITA - Outcomes Report

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Misinformed income-tax filers miss out on benefits they are entitled to such as tax credits (e.g., Child Tax Credit), deductions (home-mortgage interest deduction) and/or refunds. Inaccurate tax filings can result in unexpected penalties and/or a large tax bill. A trained tax preparer can help Iowans avoid missteps, however the average tax preparation fee was $175 in 2021, making these services unaffordable. Without access to tax preparation services, Iowans prepare their own taxes and miss out on important benefits, or they do not file their taxes at all which could result in penalties and back taxes.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In FY21, the Volunteer Income Tax Assistance (VITA) program was maintained by three human sciences program specialists who trained and supported 68 volunteers to successfully complete the IRS certification exams for tax preparation. Through outreach and administrative support, thirteen county extension offices across Iowa assisted almost 1400 Iowans (n=1377) with low- and moderate-income to access free, accurate tax preparation and to connect to critical tax credits.

Increase access to free, accurate and trustworthy tax preparation by making VITA programs available

- There were **1377** tax returns filed

- There were **13** total program sites

- There were an estimated **1848** hours of tax preparation services available

Increase the number of trained community volunteers to support to the VITA program, including volunteers who successfully complete the IRS certification exams to be able to offer tax preparation

- There were **68** total VITA volunteers

Increase financial security awareness of low- and moderate-income individuals and families by helping them access the EITC and avoid paying for tax preparation fees

- **341** tax returns contained Earned Income Tax Credit requests

Create economic impact in local communities where VITA is offered

- There was **$2,197,332** in total refunds;

- There was **$495,767** in EITC refunds;

- There was **$51,772** value of volunteer time;

- There was **$240,975** value of fees saved

Briefly describe how your target audience benefited from your project's activities.

VITA helped Iowans secure sizable refunds, created savings by providing free tax preparation fees, and helped Iowans get tax breaks through the EITC. The VITA program helped bring in more tax revenue to Iowa by helping 341 workers and families with low- to moderate-income access federal tax dollars, leading to $495,767 claimed in the Earned Income Tax Credit, boosting family income. The VITA program also helped 1377 Iowans save approximately $240,975 on tax preparation fees.

Briefly describe how the broader public benefited from your project's activities.

Without the VITA program, funds from tax benefits and tax credits would have otherwise gone unclaimed. The direct and indirect flow of money saved from the VITA program circulates in the local economy, bolsters family financial well-being, strengthens neighborhoods, assists small businesses, and spurs local economic development.

Critical Issue

Natural Resources and Environmental Stewardship

Iowa Master Conservationist Program
Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001618

Iowa Master Conservationist Program

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Prudent management of natural resources and sustainable conservation practices are necessary for maintaining and supporting healthy Iowa ecosystems. Healthy ecosystems support fertile farmlands, clean water and air, and places of natural beauty for human enjoyment. The Master Conservationist Program aims to increase knowledge of Iowa's ecosystems and knowledge of conservation practices that help sustain and protect Iowa's natural resources. Participants are encouraged to share this increase in knowledge with people in their communities to increase the amount of sustainable conservation practices done by members of their community. The outcomes of this program will protect water, wildlife, and natural resources, all of which have public value.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Each year, several counties throughout Iowa organize and lead the Master Conservationist Program. This seven-week program is laid out in a flipped classroom style. Participants watch recorded lectures and complete assigned readings before attending in-person field sessions with natural resources professionals. Topics covered in the program include:

- Land, water, and conservation in Iowa

- Understanding Iowa's Ecosystems: Prairies

- Understanding Iowa's Ecosystems: Forests

- Understanding Iowa's Ecosystems: Aquatic Environments

- Putting it together in the Watershed

- Planting the Seeds of Conservation

Each topic is addressed in an online module, and then an in-person field day accompanies each online lesson. Local conservation professionals serve as co-educators in this program. County staff identify local professionals in their County Conservation office, Department of Natural Resources office, or local natural resources non-profit to serve as educators during the field portion of the course.

Briefly describe how your target audience benefited from your project's activities.

Each participant was sent two online surveys developed and delivered through Qualtrics; one at the start of the course associated with the first online learning module (pre-course assessment), and one after completion of the last meeting via email from the local course organizers (post-course assessment). Participation in the pre-course assessment was stronger (n = 153 respondents among 161 participants; 95%) than participation in the post-course assessment (n = 99 respondents; 61%). This trend is consistent with past annual evaluations.

The post-course assessment asked respondents to self-evaluate and rate their knowledge on each subject area covered in a module before and after completing the course. All respondents indicated improvements in self-assessed knowledge for each module. Paired t-tests for each subject area demonstrated statistically significant improvements in mean knowledge scores before and after the course, with mean improvements ranging from 3.3 points to 3.8 points. Participants were asked to rate their overall satisfaction on four course elements and demonstrated high satisfaction.

Ninety-seven percent of respondents reported the online materials "improved their learning experiences in the program" while 3% indicated they "had no impacts on learning in the program." A total of 97 respondents answered the question "Would you recommend enrolling in this program to friends or family," with 94% saying yes and the remaining 6% saying "maybe." Ninety-six percent of respondents indicated they believed the program was successful in meeting the goal of creating a community of passionate conservationists.

In an attempt to measure planned changes in land use and resource stewardship behaviors as a result of the program, participants were asked if they planned to implement practices or principles learned in the MCP on land they own or have influence over. All 91 respondents that answered this question replied "yes" indicating they did plan to apply lessons to land they owned or had influence over. Of those, 83% indicated they intended to apply lessons from the class to their "home yard or farmstead." These respondents reported an intent to impact 755 acres of home yards or farmsteads. Respondents also declared an intent to impact a number of other land uses including aquatic ecosystems (31% of respondents, 1,279 acres), city parks or public natural areas (27% of respondents, 559 acres), cropland (25% of respondents, 30,874 acres), forested areas (33% of respondents, 2,647 acres), pasture (11% of respondents, 273 acres), prairie areas (36% of respondents, 2,604 acres), and other land uses (5% of respondents, 3,705 acres). In total, respondents indicated an intent to impact 42,698 acres of land with lessons from the class.

Measure #1: Percentage of participants who report an increase in knowledge of prairie forest and aquatic ecosystems.

100%

Measure #2: Percentage of participants who report an increase in knowledge of conservation practices in Iowa.

100%

Measure #3: Percentage of participants who report increased confidence their ability to communicate natural resources knowledge and practices to others.

100%

Measure #4: Percentage of program participants that increase their engagement and leadership in local natural resources efforts.

Not measured in 2021.

Briefly describe how the broader public benefited from your project's activities.

It is anticipated the broader public benefits from participants' engagement in the Iowa Master Conservationist Program by the maintaining of healthy Iowa ecosystems that support fertile farmlands, clean water and air, and places of natural beauty for Iowans' enjoyment.

Iowa Watershed Academy
Project Director
Keli Tallman
Organization
Iowa State University
Accession Number
7001615

Iowa Watershed Academy

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

In Iowa's 2020 impaired water listing, the most recent assessment of Iowa's waterbodies, only 1% of water segments assessed achieved all water quality standards for their designated use. Iowa's major land use is row crop agriculture, predominantly corn and soybeans that actively grow on the landscape for only three to five months out of the year. This absence leaves the soil vulnerable to nutrients and sediment being washed out of fields and into our shared waterbodies. This reality is also expressed nationally where Iowa is one of the major contributors to the Gulf of Mexico Hypoxic Zone, an area of very low oxygen that has resulted from farm nutrients like nitrogen and phosphorus being deposited in high concentrations. In 2012, Iowa developed the Iowa Nutrient Reduction Strategy, a statewide effort to reduce nitrogen and phosphorus loads. In order to reduce nitrogen loads by 41% and phosphorus loads by 29% in agricultural landscapes, the Strategy created scientifically-grounded scenarios for conservation adoption that are necessary to reach this goal. While progress has been made, accelerated conservation adoption, led by watershed coordinators, is needed.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Iowa Watershed Academy is held twice each year. In 2021, two academies were held to address current watershed coordinators and conservation practitioner needs. The Fall 2021 Iowa Watershed Academy focused on edge of field practice outreach and surveying and cover crop management to address farmer and landowner goals. Thirty participants engaged in the fall Watershed Academy.

Briefly describe how your target audience benefited from your project's activities.

A survey was sent out the day after the Watershed Academy concluded to all attendees, 20 responded for a 67% response rate. They were asked to agree/disagree on a 5 point scale with the usefulness of each topic and speaker. For each presentation the majority of attendees state they "strongly agree" or "somewhat agree" that the presentation was useful. The most enthusiastically positive response was for the Conservation Practitioner Poll session with 95% reporting they "somewhat agreed or strongly agreed" they learned something valuable about conservation practitioner needs. Eighty-five percent reported they agree or strongly agree they learned something valuable about edge of field practice surveying, 75% reported they agree or strongly agree they learned something valuable about cover crop management, 75% reported they agree or strongly agree they learned something valuable about farmer cover crop motivations and management from the farmer panel session and 70% reported they agree or strongly agree they learned something valuable about strategies for outreach and being a successful watershed coordinator from the Watershed Coordinator Success Story Discussion.

Attendees were also asked to list one to two takeaways from each presentation and to provide recommendations or thoughts for future academies. When asked about their intention to share information they learned with colleagues or other conservation professionals in their office, 95% of participants "agreed or strongly agreed". General feedback and recommendations for future academies were generally positive, for example: "This was an excellent event. Great speakers and information was shared," "I really appreciated the balance between real conversations and learning lessons from other project coordinators, field events to learn new skills, real conversations with farmers and demos of their conservation practices, technical info, social time, location, etc. REALLY GOOD conference!! Very well done. Thank you!!"

Briefly describe how the broader public benefited from your project's activities.

It is anticipated the broader public benefits by participants engaging in the Iowa Watershed Academy by the anticipated improvement of water quality in shared waterbodies across Iowa.

Sustainable Solutions to Problems Affecting Bee Health

Project Director
Amy Toth
Organization
Iowa State University
Accession Number
1020648

⭐ **Sustainable Solutions to Problems Affecting Bee Health**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This project addresses drivers and potential solutions to challenges to bee health in agro-ecosystems. It involves studies of both managed honey bee hives and wild bee populations, as well as their interactions. The central questions we are resarching are: does agricultural intensification negatively impact bee health? If so, is this due primarily to lack of forage and habitat, pesticides, or both? Are there interactions between these stressors in their impacts on bee health? Can practices that increase landscape complexity (e.g. prairie strips) counteract negative effects of intensive agriculture on bee health?

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We have conducted several major activities to address these questions, using a combination of field and laboratory studies.

First, we placed and monitored large numbers of beehives at multiple different sites throughout central Iowa (corn and soybean fields, prairies, and crop fields with prairie strips integrated into them). Bee hives were regularly monitored for weight, bee and brood population, and queen status, and individual bees were collected for laboratory analyses. Laboratory analyses include nutritional indicators measures (size, weight, lipid and protein stores), gene expression patterns (e.g., for genes related to stress, nutritional signaling), and measurement of pathogen loads (Nosema and virus levels). In addition, targeted netting and bee pan trap sampling are used in these field sites to observe and sample the wild bee community, along with plant community sampling. These wild bee community samples were identified to species in the laboratory, allowing for an understanding of patterns of bee community response to landscape and environmental stress. We are also processing samples of bees, pollen, and plants using GC-MS to document levels of pesticide exposure to bees in agricultural as well as restored prairie settings.

We are in the process of analyzing and publishing the data from these studies. Thus far, major results from our work include the following:

- The data suggest hive weight does not differ between soybean sites managed under different insecticide treatment regimes; however, the data do suggest "legacy" effects in which hives from insecticide-treated soybean fields failed to realize the full benefits of prairie habitat. Tracking hive mortality, we found no difference in winter survival between hives that were placed in prairies vs. those that remained in soybean fields. Overall, these findings provide some preliminary support for our hypothesis that prairie habitat can help to rescue bees from late season health decline, and suggest more subtle, long-term effects of insecticide exposure on colony health.

- At the same time, we also made biweekly collections, using modified pan traps called "bee bowls," of free flying wild pollinators from all field sites, in order to identify bee species present, their abundance, and diversity at all field sites. We developed a method to identify wild bees in the genus Lasioglossum down to morphospecies, and are in the process of completing bee identification for all three years of data combined. In addition, using laboratory assays, we assayed levels of viruses in honey bees and bumblebees collected from the soybean and prairie sites for several common honey bee viruses. Our results suggest bumble bees in prairie sites with honey bees may have increased exposure to common honey bee viruses such as deformed wing virus; however, we found no evidence of negative effects of honey bee presence on short term measures of wild bee abundance/diversity.

Summaries of publications related to this work from the last reporting period include:

In St. Clair et al. 2020, we demonstrated benefits to both honey bee colonies (in terms of hive weight) and wild bees (in terms of community abundance and diversity) when comparing diversified fruit and vegetable farms to conventional soybean farms. This work contributes to our understanding of the important role of landscape and forage diversity for both managed and wild bee health.

In Zhang et al. 2021, we collected and identified pollen collected by honey bee hives placed in restored prairie locations. We found that bees utilize native prairie plant species as forage, especially in the late season when crop and weedy species have senesced. This suggests native prairie can provide an important source of food for bees during a critical time in the season.

In DeGrandi-Hoffmann et al. 2021, we utilized hives from the NIFA funded project to collaborate with the Tucson USDA Bee Lab. This work demonstrated seasonal differences in the nutritional composition of pollen collected by honey bees, helping us understand the seasonal fluctuations and nutritional requirements of honey bees.

In Pritchard et al. 2021, we examined wild bee communities and bumble bee health indicators at prairies on which the honey bee colonies had been placed. We found no negative impact of honey bees on the abundance or diversity of foraging wild bees. We found some evidence that free flying bumblebees in prairies with apiaries were more likely to harbor honey bee viruses; however, the viral loads were very low. It remains to be determined if these low viral loads have any negative impact on wild bee health.

Briefly describe how your target audience benefited from your project's activities.

Extension Specialist Randall Cass has been actively engaged in the extension component. In the last reporting period, much of this was done virtually due to the COVID-19 pandemic. This involved a large number (32) of presentations (e.g., with the University of Nebraska at Lincoln, ISU Extension and Outreach Communications, North Central IPM Center) and events (a frequent online meeting group Cass instigated in collaboration with Judy Wu-Smart at the University of Nebraska Lincoln ("HapBee Hour"). Research results from the NIFA funded project have been integrated into extension materials and presentations related to insecticide usage, beekeeping, and conservation management. Cass has a manuscript in preparation that describes the results of surveys of farmer and beekeeper attitudes and management practices related to bees and bee conservation. Survey results indicate high levels of landowner/farmer interest in pollinators and bee declines, and a tendency

for beekeepers to underestimate the importance of forage and nutrition in bee health. Cass has also continued to actively maintain the Iowa State Bees Instagram account, posting photos, videos, and informational blurbs to over 1000 followers. We also produced two informational YouTube videos related to requeening hives and splitting and recombining hives. Through presentations across the region, we have reached over 2000 people during the course of this project.

Briefly describe how the broader public benefited from your project's activities.

We continue to present our research findings to the scientific community and engage in education and outreach activities related to pollinator health and bee biology. Several of these activities were canceled or postponed in 2020 due to the COVID19 pandemic. Randall Cass continued organizing and increasing the visibility of our program through social media and the Iowa State Pollinator Working Group website, the Iowa State Bees Instagram account with over 1000 followers, and presented 32 virtual talks at beekeepers' meetings, farmer meetings, and conservation group meetings. Cass has been actively developing the extension component of our project, involving website improvements and social media presence, developing extension materials, giving presentations and attending stakeholder meetings, and designing and conducting surveys of stakeholders. Cass has shared research results from this project, disseminating information to hundreds of people in the past year alone, and created extension publications and videos related to beekeeping and the use of CRP land for honey bee health.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Former graduate student Ashley St. Clair has authored numerous publications related to the work, and transitioned to a postdoctoral position at the University of Illinois with coPI Dolezal, where she has secured a USDA Postdoctoral Fellowship to pursue work related to this project in the future. Extension specialist Randall Cass has continued on in a research teaching-extension-honey production position at Iowa State University, where he continues to contribute productively to bee health-related initiatives. Graduate student Kate Borchardt was supported as an RA to conduct an additional field study, addressing the potential benefits of prairie habitat (in the form of prairie strips) for wild bees and plant-interactions, in addition to studying effects of the presence of honey bees on wild bees in these prairie restorations. We provided valuable research experiences for multiple research assistants and undergraduates (Maria Cline, Joy Westercamp, Kenneth Snell, Kavita Jain, Paola Soto-Mendez, Olivia Meyer, David Stein, Morgan Moore, Ayrin Alexander, and Danielle Holthaus). In addition, Toth developed a new undergraduate research internship program in 2021, the Bee and Wasp squad, which provided in-depth research training for four undergraduates, including several members of underrepresented groups in STEM. These students are doing on to graduate school (2), veterinary school (1), and jobs in conservation biology (1).

Soil, Water, and Environmental Physics to Sustain Agriculture and Natural Resources
Project Director
Robert Horton
Organization
Iowa State University
Accession Number
1020934

⭐ New sensor that measures soil water content and water potential simultaneously

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Soil water status is determined by water content and water potential. Very few sensors are able to measure water content and water potential simultaneously. We developed a new heat pulse based sensor to determine soil water content and soil water matric potential.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

A new dual-probe heat pulse (DPHP) sensor was developed to simultaneously measure soil thermal properties, soil water content and soil water matric potential. A series of experiments were performed to evaluate the sensor performance. The new sensor was able to measure each soil property quite accurately. The accuracy of the matric potential determinations was approximately 10% in log scale. The effective range for ψ measurements was − 1000 to − 2.5 m of water, and the accuracy of the ψ determinations was best between − 350 and − 2.5 m of water, which included values of field capacity and wilting point for most soils and crops. The sensor was effective over the entire range, dry to wet, of soil water content values. The sensor design included a single heater wire to provide simultaneous heat inputs to two different materials, i.e., the soil and the sensor porous medium. The single heater wire did not influence sensor accuracy as long as the soil and the sensor porous medium thermal conductivity values were not significantly different. The new DPHP based sensor effectively measured soil water matric potential, soil water content, and soil thermal property values.

Briefly describe how your target audience benefited from your project's activities.

Scientists benefitted from a number of project-related publications:

Fu, Y., R. Horton, T. Ren, J.L. Heitman. 2021. A general form of Archie's model for estimating bulk soil electrical conductivity. J. Hydrology 597, https://doi.org/10.1016/j.jhydrol.2021.126160

Fu, Y., R. Horton and J.L. Heitman. 2021. Estimation of soil water retention curves from soil bulk electrical conductivity and water content measurements. Soil Till. Res. 209, https://doi.org/10.1016/j.still.2021.104948

Fu, Y., Lu, S., Ren, T., Horton, R., Heitman, J.L., 2021. Estimating soil water retention curves from soil thermal conductivity measurements. J. Hydrol. 603, https://doi.org/10.1016/j.jhydrol.2021.127171

He, H., Aogu, K., Li, M., Xu, J., Sheng, W., Jones, S.B., González-Teruel, J.D., Robinson, D.A., Horton, R., Bristow, K., Dyck, M., Filipovi?, V., Noborio, K., Wu, Q., Jin, H., Feng, H., Si, B., Lv, J., 2021. A review of time domain reflectometry (TDR) applications in porous media. Advances in Agronomy 83–155. https://doi.org/10.1016/bs.agron.2021.02.003

He, H., G.N. Flerchinger, Y. Kojima, D. He, S.P. Hardegree, M.F. Dyck, R. Horton, Q. Wu, B. Si, J. Lv, and J. Wang. 2021. Evaluation of 14 frozen soil thermal conductivity models with observations and SHAW model simulations. Geoderma 403, https://doi.org/10.1016/j.geoderma.2021.115207

Horn, R., Y. Lu, T. Ren, R. Horton, A. Mordhorst, and H. Fleige. 2021. Derivation of the thermal soil functions by grain size and pore size distribution as a basis for in situ predictions of the soil heat balance. Die Bodenkultur: Journal of Land Management, Food and Environment 72:33–43, 2021. https://DOI:10.2478/boku-2021-0004

Ibrahim, A., & Horton, R. 2021. Biochar and compost amendment impacts on soil water and pore size distribution of a loamy sand soil. Soil Sci. Soc. Am. J., 1–16. https://doi.org/10.1002/saj2.20242

Kojima, Y., Kawashima, T., Noborio, K., Kamiya, K., Horton, R., 2021. A dual-probe heat pulse-based sensor that simultaneously determines soil thermal properties, soil water content and soil water matric potential. Computers and Electronics in Agriculture 188, https://doi.org/10.1016/j.compag.2021.106331

Lu, Y., Peng, W., Ren, T., Horton, R., 2021. Applications of thermo-TDR sensors for soil physical measurements. https://doi.org/10.5772/intechopen.100285

Lü, H., Wang, Q., Horton, R., Zhu, Y., 2021. The response of the HydroGeoSphere Model to alternative spatial precipitation simulation methods. Water 2021, 13,1891. https://doi.org/10.3390/w13141891

Peng W, Lu Y, Ren T, & Horton, R. 2021. Application of infinite line source and cylindrical-perfect-conductors theories to heat pulse measurements with large sensors. Soil Sci. Soc. Am. J. 85:1050-1059. https://doi.org/10.1002/saj2.20250

Tekeste, M.Z., Ebrahimi, E., Hanna, M.H., Neideigh, E.R., Horton, R., 2021. Effect of subsoil tillage during pipeline construction activities on near?term soil physical properties and crop yields in the right-of-way. Soil Use Manage. 37, 545-555. https://DOI:10.1111/sum.12623

Tian, Z., J. Chen, C. Cai, W. Gao, T. Ren, J.L. Heitman, and R. Horton. 2021. New pedotransfer functions for soil water retention curves that better account for bulk density effects. Soil Till. Res. 205, https://doi.org/10.1016/j.still.2020.104812

Wang, Y., R. Horton, X. Xue, and T. Ren. 2021. Partitioning evapotranspiration by measuring soil water evaporation with heat-pulse sensors and plant transpiration with sap flow gauges. Agric. Water Mgmt. 252, https://doi.org/10.1016/j.agwat.2021.106883

Wang, Z., Thapa, R., Timlin, D., Li, S., Sun, W., Beegum, S., Fleisher, D., Mirsky, S., Cabrera, M., Sauer, T., Reddy, V.R., Horton, R., Tully, K., 2021. Simulations of water and thermal dynamics for soil surfaces with residue mulch and surface runoff. Water Resour. Res. 57, e2021WR030431. https://doi.org/10.1029/2021WR030431

Wang, Z., D. Timlin, Y. Kojima, C. Luo, Y. Chen, S. Li, D. Fleisher, K. Tully, V.R. Reddy and R. Horton. 2021. A piecewise analysis model for electrical conductivity calculation from time domain reflectometry waveforms. Comput. & Electron. Agric.182, https://doi.org/10.1016/j.compag.2021.106012

Young, N.L., W.W. Simpkins and R. Horton. 2021. Are visible fractures accurate predictors of flow and mass transport in fractured till? Groundwater 59:24-30. https://doi:10.1111/gwat.13013

Briefly describe how the broader public benefited from your project's activities.

The broader public benefits from this first step toward developing a commercial sensor that can be broadly used to monitor soil water status.

MONARCH BUTTERFLY CONSERVATION
Project Director
Steven Bradbury
Organization
Iowa State University
Accession Number
1014243

⭐ Determining optimal habitat for monarch butterflies in agricultural landscapes of the Midwest

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Monarch butterflies are an endangered species--their populations are in decline. Fifty percent of monarchs that winter in Mexico orginate in the midwestern United States. Therefore, there is a need to determine how monarch habitat is influenced by agricultural fields in the Midwest and how to enhance habitats near midwestern agricultural fields to assist in monarch population recovery. Our research supports monarch conservation in Midwestern agroecosystems.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Research this period advanced techniques to assess the financial costs and benefits of converting grass-dominated sites to monarch habitat. We published a study documenting that establishing monarch habitat results in significant savings as compared to the costs of managing turf or grass-dominated fields.

We also published a study indicating that the exposure of neonicotinoid insecticides to milkweed established near corn and soybean fields is unlikely to cause significant risk to monarch larvae. Another published study suggested that the emerging use of double-stranded RNA technology to manage pests in corn and soybean production is also not likely to pose risks to monarchs. These findings were shared with stakeholders in a covid-19 environment with social media and online presentations at scientific meetings.

Habitat quality and monarch utilization data was collected for 35 Iowa sites (27 private landowners and 8 ISU owned/operated research farms) with survey and sampling protocols previously reported. These sites were not sampled in 2020 due to covid 19. Summary of survey results and recommended habitat management practices will be provided to each landowner. A manuscript addressing the economic benefits of converting grass-dominated sites to monarch habitat was published in the Journal of Fish and Wildlife Management. A pilot project was initiated to determine continental dispersion of adult monarchs based on mitochondrial genome-wide variation combined with stable isotope analysis.

Research results were communicated to stakeholders through a variety of educational outreach activities. With the covid pandemic, it was not possible to hold field days. Research results were delivered to stakeholders through a library of short videos (3 new videos in 2021) available online [https://monarch.ent.iastate.edu/video], social media via @IowaMonarchs, and interviews with media and farm publications, as well as a state-wide virtual extension meeting. A virtual presentation for the Iowa Conservation Education Coalition was also provided. Presentations were provided virtually at professional societies, including the Society of Environmental Toxicology and Chemistry, and the North Central Branch of the Entomological Society of America. The Iowa Monarch Conservation Consortium met in February and December, 2021 and were provided updates.

Last year's report summarized research that evaluated the extent to which larvae move on and between ramets (individual plants within a colony of like plants) and the extent of intra-specific competition of larvae on the same milkweed stem. This year analyses of studies assessing intraspecific competition of monarch larvae for one series of experiments were completed. The study indicated larvae engage in cannibalism during starvation; as the instar stage increased, cannibalism was more frequent. A second study determined how larval density and limited food availability played a role in larval cannibalism. Additional analyses were completed to provide best practice for establishing common milkweed in brome. Results show that planting rhizomes is more successful as compared to seeding and planting milkweed plugs. However, less labor is required when planting seeds. Results to date suggest that milkweed only patches in a brome-dominated landscape can connect other patches and larger restorations. These findings were reported in a MS thesis and are being prepared for submission to Ecological Restoration and Environmental Entomology.

Because milkweed patches will be established near corn and soybean fields planted with neonicotinoid-treated seeds there is concern monarch larvae could be at risk due to consumption of milkweed that have absorbed these insecticides. Findings from field surveys indicated the level of neonicotinoid exposure is low and these insecticides are unlikely to impact monarch larvae. We also published a paper in PLOS ONE indicating that the emerging use of RNAi technology to manage insect pests will likely not cause adverse effects to monarchs utilizing habitat in close proximity to treated fields. Based on our research with monarchs, we published an approach) to estimate risks of pesticide use to other butterfly species of conservation concern in the north central region (in: Crop Protection Products for Sustainable Agriculture. American Chemical Society Symposium Series).

Briefly describe how your target audience benefited from your project's activities.

The target audiences for this project are agricultural producers, county, regional and state-based extension personnel, agricultural commodity groups, agricultural-based industries, and individuals interested in establishing monarch habitat in Iowa. Partners include agribusiness, conservation organizations, state agencies (Iowa DNR, IDALS), NGOs, and federal agency professionals. Our research, publications and presentations increased the understanding of these target audiences regarding farm practices and concervations practices that do or do not influence monarch butterfly populations. This work aids in the development of monarch conservation practices on or near agricultural fields in the Midwest.

Briefly describe how the broader public benefited from your project's activities.

Our research results will inform USFWS' 2024 Endangered Species Act listing decision and associated conservation practices being developed by USDA and stakeholders in agricultural communities. This work aids landowners, and agricultural producers and their advisors, in the development of Midwestern monarch conservation practices, which will, in turn, lead to increases in monarch butterfly populations.

Investigations into Aquatic Resources Biology, Ecology and Management
Project Director
Joseph Morris
Organization
Iowa State University
Accession Number
1012809

⭐ **Ecology and Management of Invasive Bigheaded Carp in the Upper Mississippi River Basin**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

In recent years, several aquatic invasive fish species have become more problematic in Iowa's natural resources. The result of these infestations have been to decrease the amount of desirable fish species in favor of invasive species that have little to no value to the sportfish angler as well as displace many native fish species.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Research activities have included identification of reproducing populations of invasive species, i.e., Bighead and Silver Carps, understanding variability in their population dynamics, factors that influence larval Bighead Carp densities, and understanding the spread of the invasive carps and identification of carp eggs.

Briefly describe how your target audience benefited from your project's activities.

Understanding variability in population characteristics and dynamics of invasive species is important for developing successful management strategies. Here, we compiled a large dataset of Bigheaded Carp abundance, size structure, age, and growth data from throughout their range and assessed variation in population characteristics. We then discuss how variation in populations needs to be considered when managing this invader.

Knowledge of mechanisms influencing successful reproduction of invasive species is needed to understand and control their spread. This analysis evaluated factors influencing larval Bigheaded Carp densities along the leading edge of the invasion in the Upper Mississippi River. We found successful reproduction was influenced by the number of adults present as well and high flow events during the reproductive period. This work provides new insights into factors influencing Bigheaded Carp reproduction and provides guidance on how harvest of adults could affect reproduction.

Briefly describe how the broader public benefited from your project's activities.

While the general public are aware of the general issue of invasive species to midwestern waters, they are not aware of specific issues to this region's aquatic resources. For instance, the common carp has been viewed as an introduce species in Iowa's water since the early 1900s but BIghead and Silver Carps are more recent introductions that can have an even greater impact of Iowa's native fish species.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Results are provided to interested parties through a variety of printed, digital, and audio media outlets. Over the past year, Weber's lab has presented 14 times at professional conferences and to stakeholder groups. We have written a number of technical reports and published 20 peer-reviewed journal articles in 2021. Weber also keeps collaborators and stakeholders informed of current activities through social media (https://twitter.com/MJWeberLab). Weber works closely with partner organizations, including Iowa Department of Natural Resources, South Dakota Game, Fish and Parks, Minnesota Department of Natural Resources, US Fish and Wildlife Service, US Army Corps of Engineers, US Geological Survey, Illinois Natural History Survey, and Western Illinois University on collaborative projects. Weber have engaged in several efforts to deliver science-based knowledge to people through classroom instruction (Fisheries Management, Fisheries Techniques) and informal seminars (Ames Anglers, Iowa Great Lakes Fishing Club).

Publications

Erickson, RA, JL Kallis, AA Coulter, DP Coulter, R MacNamara, J Lamer, WW Bouska, K Irons, L Solomon, MJ Weber, MK Brey, †C Sullivan, GG Sass, JE Garvey, and DC Glover. 2021. Demographic variability of two invasive species along an invasion gradient: Bighead and silver carps in the Illinois, Ohio, and Mississippi rivers, USA. Journal of Fish and Wildlife Management 12:338-353.

Weber MJ, A Matthews†, and CL Pierce. 2021. Effects of adult biomass and environmental conditions on Bigheaded Carp reproductive output. Journal of Fish and Wildlife Management 12:373-382. Journal of Fish and Wildlife Management 12:373-382.

Goode K, Weber MJ, A Matthews†, and CL Pierce. 2021. Evaluation of a random forest model to identify invasive carp eggs based on morphometric features. North American Journal of Fisheries Management.

Camacho, CA, †CJ Sullivan, MJ Weber, and CL Pierce. 2021. Suitability of an Upper Mississippi River tributary for invasive carp reproduction. North American Journal of Fisheries Management.

Sullivan, CJ, MJ Weber, CL Pierce, DH Wahl, Q Phelps and R Columbo. 2021. Spatial variation in Silver Carp population ecology throughout the upper Mississippi River basin. Ecology of Freshwater Fish 30: 375-390.

Camacho, CA, †CJ Sullivan, MJ Weber, and CL Pierce. 2021. Invasive Carp reproduction phenology in tributaries of the Upper Mississippi River. North American Journal of Fisheries Management.

⭐ Restoration of Wetland Functions

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Restoration of wetland functions requires knowledge of causal linkages between human activities and wetland attributes. Stewart evaluated direct and indirect effects of human activities (including land use and invasive fishes) on plant, macroinvertebrate and aquatic vertebrate communities within semi-permanently and permanently flooded wetlands.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Dr. Stewart and his students have found that wetland depth and surface area increase with land-use intensity, and that invasive fish abundance is positively associated with wetland water volume. Results from this research, specifically strength of relationships among land use and physical and biological variables, is being used to identify a set of cost-effective metrics for inclusion in a wetland condition assessment protocol for Iowa wetlands. Results also indicate that restored oxbow wetlands support high species diversity, and function as essential habitat for the Topeka Shiner, a species of fish that is classified by the United States Fish and Wildlife Service as an endangered species.

Briefly describe how your target audience benefited from your project's activities.

In addition to Iowa's rivers, lakes and ponds, wetlands also have importance in maintaining and improving habitat for many aquatic species including endangered species. Inclusion of this knowledge is important to develop management plans for Iowa aquatic species.

Briefly describe how the broader public benefited from your project's activities.

Public education about Iowa's resources often focus only on rivers, lakes and ponds but not on wetlands. Information from this project will help to illustrate the role of Iowa's wetlands on natural populations of aquatic species and how their management is needed.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Training has included graduate student education as well as their professional training.

Publications

Osterhaus, D.M., Leberg, S.S., Pierce, C.L., and Stewart, T.W. 2021. Return of Topeka Shiner to restored oxbows in the White Fox Creek watershed, Iowa, USA. Journal of the Iowa Academy of Science 128:3-6.

S. Leberg. 2021. Effects of tile drainage on restored oxbows as habitat for endangered Topeka Shiners and other biota. M.S. Thesis, Iowa State University.

D. Osterhaus. 2021. An index of oxbow restoration quality for Topeka shiners (*Notropis topeka*) based on the fish assemblage. M.S. Thesis, Iowa State University.

Critical Issue

Transformative Technology

Agricultural machinery and technology development for advancing agricultural productivity and sustainability

Project Director
Brian Steward
Organization
Iowa State University
Accession Number
1018234

⭐ **Agricultural machinery and technology development for advancing agricultural productivity and sustainabilit**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Machine systems, to operate effectively, need to incorporate more knowledge of the cropping system into their design and operation. This project addresses the limited understanding of the interaction of agricultural machines and cropping systems, need for model development, and the potential of big data as a tool.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We have continued to develop robotic solutions for field-based plant phenotyping to meet our goal of developing new methods of sensing and data analytics to advance scientific research and automation systems. Efforts have been put into the improvements of the PhenoBot design, instrumentation, navigation control, and the redesign of our 3D stereo vision module – PhenoStereo. On top of the algorithms for maize plant stalk size sensing and leaf angle measurement, new algorithms for maize plant leave area sensing and soybean plant seed pod characterization are being developed. Another image processing project was on sweet potato harvest loss characterization by using UAV captured aerial images via deep learning approaches.

Additionally, data-driven and decision support tools are also being developed through the project to enable and empower producers and resource planners to identify efficiencies that lead to higher productivity and profitability of their operations, and target production strategies to different landscape positions informed by data and models.

In the recently established Soil Machine Dynamics Laboratory (SMDL), single tire-soil interaction research has started to investigate the relationship of tire inflation pressure management for low-ground-pressure tire technologies. Mobility tests were conducted to support the development of standard tire and track foot-print estimation of 2D and 3D soil rut depth, along with area and volume of displaced soil.

In related work, understanding soil-tool interaction can enable better control of weeding tools to achieve higher weeding efficacy. The interaction between a vertical tine mounted on a rotating disc and soil was investigated using a mathematical model that estimated soil horizontal forces on the tine operating at different linear and rotational velocities. The research showed that the variations in shear and inertial forces on the tine were due to differences in soil failure patterns across the treatments. Predicted forces for two tines using the model showed trends that were similar to the forces measured in the experiment. These results are helpful for the development of physical weeding tools to have weed control efficacies similar to those of chemical weed control approaches.

The off-highway chassis dynamometer was installed. Commissioning of the equipment started with a goal of being fully operational in the 2022. Funding was obtained for vehicle emissions equipment to enable the testing of full vehicles to investigate the effect of vehicle powertrain controls on emissions levels. This lab will enable investigations of full vehicle power systems seeking to improve the delivery of power to agricultural production systems.

In related agricultural vehicle work, hydrostatic and hydro-mechanical transmissions are commonly used in off-highway vehicles. While both transmission technologies can provide continuously variable torque or speed ratios, they suffer from poor efficiencies and limited operating ranges. Electric variable transmissions, in contrast, offer complementary strengths via higher efficiencies at low forward and reverse speeds, full torque from zero to full power, and increased control capabilities. A physical modeling methodology was developed to explore different power-split transmission technologies using hydraulic, electrical, and mechanical pathways to understand how the complementary nature of the technologies could be used for overall power transmission performance.

Hydraulic pressure ripple in a pump, as a result of converting rotational power to fluid power, continues to be a problem faced when developing hydraulic systems due to the resulting noise generated. To address this problem a machine learning approach was used as the control method for active noise control in a hydraulic system. The simulation results demonstrated substantial pressure ripple reductions and responsiveness in control the pressure generated noise during changes in the operating conditions. Such techniques that use new methods of sensing and data analytics in complex mechanical and fluid systems will serve to enable to higher performing agricultural machinery.

Briefly describe how your target audience benefited from your project's activities.

Results have been distributed through traditional methods of peer-reviewed publications as well as directly to agricultural producers. The applied nature of this research is well suited for joint distribution both to the scientific community as well as direct distribution to producers and retailers who can immediately implement this new knowledge. Of particular interest was the focused delivery of planting systems and fertilizer application technology information directly to ag retailers through a series of extension and outreach meetings. Feedback from these meetings documented both the high value of this research effort as well as the timely nature of these results which helped to address several short term challenges for producers and retailers. This information has since been incorporated into internal training and best practice materials for over a dozen ag retailers, crop service providers, ag equipment dealers, and insurance companies in the Midwest. **On an annual basis this approach to "train-the-trainer" will help ensure the long term impact and use of these results to enhance agricultural productivity and environmental sustainability.**

Additionally, a key focus of 2021 involved improved outreach education specifically focused on planting systems and the interaction between mechanical planting systems and plant development in large grains. This program team delivered several milestone outcomes as part of this outreach effort including:

- Contributed to dedicated training materials focused on improving planting system performance in cover crop systems.

- Led and delivered 30 hrs of in-person intensive education on planting systems with direct engagement on over 500,000 acres of large grains production in Iowa.

- Provided regular news articles and blog posts specifically targeting planting system performance and decision making at the interface of mechanical systems and soil systems for optimizing planting.

Additional outcomes have been disseminated through online educational content targeting professionals in the advanced machinery engineering discipline. In total 10 hrs of online content was produced and distributed to targeted industries that are served by this project. The direct outcome of this effort helps to support regional businesses in the Midwest US to stay active and aware of technology trends and scientific discovery. This supports economic development within the region and promotes innovative product delivery for ag producers.

Additionally, online seminars have been given to international audience in seed science and technology and agricultural genome to phenome initiative program on robotic plant phenotyping with recorded presentations publicized on the internet.

Five specific audiences are impacted by the results of this project. These audiences include:

1. Agricultural Producers: Results from relevant research are disseminated directly to agricultural producers through active engagement with state and national extension programming efforts.

2. University Students: Results are integrated into academic coursework at Iowa State University and knowledge generated is transferred to students in relevant courses.

3. Academic and Scientific Community: Peer reviewed results are disseminated through leading academic journals to enhance the knowledge base within the agricultural engineering scientific community. Technical book chapters, for example, impact graduate students and emerging scholars who are gaining understanding of the state of knowledge in the area.

4. Agricultural Machinery Industry: Results are shared with peers in the agricultural engineering and agricultural machinery industry. These results create new partnerships to enhance scientific knowledge as well as create a portal for those results to be transferred directly to agricultural producers through commercial implementation.

5. Plant science industry: Results are shared with scientists in agricultural genetics companies as well as developed technology is adopted for the development of plant traits.

Briefly describe how the broader public benefited from your project's activities.

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Xiang, L., Nolan, T.M., Bao, Y., Elmore, M., Tuel, T., Gai, J., Shah, D., Wang, P., Huser, N.M., Hurd, A.M., McLaughlin, S.A., Howell, S.H., Walley, J.W., Yin, Y. and Tang, L. 2021. Robotic Assay for Drought (RoAD): an automated phenotyping system for brassinosteroid and drought responses. Plant J. (doi: 10.1111/tpj.15401)

Gai, J., L. Xiang, L. Tang. 2021. Using a depth camera for crop row detection and mapping for under-canopy navigation of agricultural robotic vehicle, Computers and Electronics in Agriculture 188, DOI: 10.1016/j.compag.2021.106301.

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Ngo?Cong, D., Antille, D.L., Th. van Genuchten, M., Nguyen, H.Q., Tekeste, M.Z., Baillie, C.P. and Godwin, R.J., 2021. A modeling framework to quantify the effects of compaction on soil water retention and infiltration. *Soil Science Society of America Journal*, 85(6), pp.1931-1945.

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⭐ **Agricultural machinery and technology development for advancing agricultural productivity and sustainability**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Machine systems, to operate effectively, need to incorporate more knowledge of the cropping system into their design and operation. This project addresses the limited understanding of the interaction of agricultural machines and cropping systems, the need for model development, and the potential of big data as a tool.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

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Briefly describe how your target audience benefited from your project's activities.

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Additional outcomes have been disseminated through online educational content targeting professionals in the advanced machinery engineering discipline. In total, 10 hrs of online content was produced and distributed to targeted industries that are served by this project. The direct outcome of this effort helps to support regional businesses in the Midwest US to stay active and aware of technology trends and scientific discovery. This supports economic development within the region and promotes innovative product delivery for ag producers.

Additionally, online seminars have been given to international audiences in seed science and technology and agricultural genome to phenome initiative program on robotic plant phenotyping with recorded presentations publicized on the internet.

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5. Plant science industry: Results are shared with scientists in agricultural genetics companies, and developed technology is adopted for the development of plant traits.

Briefly describe how the broader public benefited from your project's activities.

The direct outcome of this effort helps to support regional businesses in the Midwest US to stay active and aware of technology trends and scientific discovery. This supports economic development within the region and promotes innovative product delivery for ag producers.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

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Closing Out (end date 09/07/2023)

Integrated Systems Research and Development in Automation and Sensors for Sustainability of Specialty Crops
Project Director
Lie Tang
Organization
Iowa State University
Accession Number
1017805

Integrated Systems Research and Development in Automation and Sensors for Sustainability of Specialty Crops

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Developing sensors and sensing systems that can phenotype and measure and interpret quality parameters of plants is of a great importance in specialty crop production and research. However, sensing crop plants in field conditions faces difficult engineering challenges, which are associated with the complex biological properties of plants, variable outdoor conditions like sunlight, wind, and terrain, along with the constraints imposed by planting requirements such as plant density and row spacing. Thus, robust crop sensing systems require integrated solutions that bring both advanced sensing and automation/robotic platforms together.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We have continued to develop robotic solutions for field-based plant phenotyping to meet our goal of developing new methods of sensing and data analytics to advance scientific research and automation systems. Efforts have been put into the improvements of the PhenoBot design, instrumentation, navigation control, and the redesign of our 3D stereo vision module – PhenoStereo. On top of the algorithms for maize plant stalk size sensing and leaf angle measurement, news algorithms maize plant leave area sensing and soybean plant seed pod characterization are being developed. Another image processing project was on sweet potato harvest loss characterization by using UAV captured aerial images via deep learning approaches.

Briefly describe how your target audience benefited from your project's activities.

Graduate and undergraduate students: Students have gained highly valuable knowledge and experiences through working on cutting-edge research projects. Results generated from our projects have been integrated into coursework.

Research community: Results have been disseminated through academic journals, book chapters, and conference presentations that can help enrich the literature that benfits graduate students and researchers.

Briefly describe how the broader public benefited from your project's activities.

Results have been shared and prompted to plant science industry. A high-throughput plant stand analyzer technology has been adopted by seed industry.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Online seminars have been given to international audience in seed science and technology and agricultural genome to phenome initiative program on robotic plant phenotyping with recorded presentations publicized on the internet.

Closing Out (end date 09/07/2023)

National Animal Genome Research Program

Project Director

Christopher Tuggle

Organization

Iowa State University

Accession Number

1018103

National Animal Genome Research Program- FY21 Report

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The use of genomics to improve the genetics of US animal-based commodities has been adopted by nearly all the food and fiber animal-breeding industries for which genomic tools have been developed. The constant advancement of next-generation sequencing (NGS) technologies and the exponential decreases in sequencing costs, have produced seismic shifts in research approaches and have substantially broadened the scope of animal genomics. These new "big data" challenges are addressed in our objectives. Harnessing the power of big data in agri-animal genomics research is only possible through coordinated teamwork efforts such as those successfully exhibited by the NRSP-8 species consortia.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

We have developed new genomic information, including data on genetic variability and functional genome annotation, as well as increased public access to such data and shared tools and resources. Due to this effort in coordinating scientists across multiple stations, we increased the knowledge of pig, and other domestic animal species, genome function. This is documented in the many papers published and meetings attended in the past year. This information can be used by at universities and breeding companies to analyze their animal's genetic makeup and accelerate genetic improvement. We also trained researchers to use genomic and high-throughput molecular data.

Briefly describe how your target audience benefited from your project's activities.

Summary:

This project has facilitated creation of new genomic information, including data on genetic variability and genome annotation, as well as increased public access to such data and shared tools and resources. Due to this effort in coordinating scientists across multiple stations, we increased the knowledge of pig, and other domestic animal species, genome function. This information can be used by multiple types of stakeholders. For example, geneticists at universities and breeding companies can use newly validated genotyping tools to analyze their animal's genetic makeup and accelerate genetic improvement. New functional information also improves such studies, as genetic variation may be in regions with function or outside of such regions. Filtering genetic data for their predicted effect on function is expected to clarify what variation is most relevant to animal traits for genetic improvement. We developed educational materials and trained researchers to use genomic and high-throughput molecular data to answer biological and genetic questions. Finally, new computational tools, descriptions of genome community activities, and maintenance of websites for public access to these tools as well as to the data described above were a major effort of the project.

Briefly describe how the broader public benefited from your project's activities.

We anticipate that the public benefits from the increased knowledge provided by this project in two ways. First, the information is available to our stakeholders, who we know use these data to more efficiently produce food and other agricultural products for consumers. Second, The public has access to all of the publications from each objective, providing visibility and transparency to our results and activities. We publish newsletters, meeting minutes, and summaries of research by all members of the community. This provides the public with an opportunity to learn about our genome activities, and connect with a researcher if there is interest in a particular project or activity.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Professional development was provided to 4-6 graduate students each year, where they orally presented their genomics and/or bioinformatics research to gain experience as a speaker. Two-three students further received support to travel to the Plant and Animal Genome Meeting from NRSP8 funds.

Results were disseminated to multiple communities in several ways. First, presentations were provided to scientific and lay audiences concerning the accomplishments and issues related to livestock genetics and genomics. Secondly, published referred journal articles, abstracts, and lay presentations were prepared, submitted and published. Third, an online discussion group "Angenmap" has conveyed information to over 4300 people, usually several times a month. Finally, both Pig Genome and Bioinformatics Coordinator reports were given orally each year at the NRSP8 Workshop in San Diego during the Plant and Animal Genome Conference.

Type	Projects / Programs
Projects / Programs without a Critical Issue	0
Not Provided	