

Iowa (Iowa State University) Annual Report - FY2022

Report Status: Approved as of 05/26/2023

Contributing Organizations

Iowa State University

Executive Summary

Overview

Iowa's agriculture sector has undergone significant growth and transformation, expanding beyond traditional crop and livestock production to encompass the latest advancements in the bioeconomy, life sciences, food sciences, environmental sciences, and social sciences. The state's rich natural resources, talented workforce, and well-established infrastructure support a diverse range of food, feed, fiber, biofuels, and bioproducts initiatives. Iowa's strategic location and robust transportation network make it an ideal location for businesses, communities, and families involved in the agriculture and biotech industries to thrive.

Iowa's agricultural industry continues to drive the state's economy, as evidenced by its impressive cash farm receipts of \$36.56 billion in 2021, ranking second nationally only to California. The state's position is strengthened by its high ranking in the production of several key commodities. In the same year, Iowa emerged as the top national producer of corn, pork, eggs, and ethanol, while also ranking second in soybeans, fifth in cattle/calf production, sixth in turkey production, and 12th in dairy products. The state's farmland spans 30,563,878 acres, with cropland accounting for 87 percent of the total farm acres in 2017. Iowa's 86,104 farms have an average size of 355 acres, with the median farm size being 142 acres.

Iowa's population of 3,200,517 in 2022 ranks 31st in the country, with 62 percent residing in the state's nine metropolitan statistical areas (MSAs). The non-metropolitan population is the 9th highest among states, with 36.2 percent of Iowa's residents living in rural territories with fewer than 2,500 inhabitants, compared to the U.S. average of 19.9 percent. The largest minority group in Iowa is the Hispanic/Latino population, which makes up 6.7 percent of the state's residents, followed by the Black or African American population (both Latino and non-Latino) at 4.3 percent, and the Asian segment of the population at 2.8 percent. The non-Latino white population accounts for 84.1 percent of the state's total population. In terms of education, minority students make up 27.5 percent of preK-12 public school enrollment in 2022-23. The poverty rate for individuals in Iowa was 11.1 percent (+/- 0.5%) in 2021, lower than the rate of 12.8 percent (+/- 0.1%) for the United States as a whole.

Ongoing demographic changes, technological innovations, and globalization present both opportunities and challenges in developing sustainable, socially responsible, and environmentally sound systems for food, feed, fiber, fuel, and other value-added products. To address these challenges, our research and extension programs focus on six critical areas:

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

Our dedicated team of researchers, educators, and Extension and Outreach professionals collaborate closely to develop and implement innovative solutions that have a positive impact on society and the environment.

The Iowa agriculture industry is supported by a robust research and Extension and Outreach community spanning a wide range of disciplines, from basic to applied, to address the challenges facing the production of feed, food, fiber, and fuel. Research and Extension and Outreach outcomes reported here are a collaborative effort involving scientists and Extension and Outreach professionals from many departments and colleges, resulting in advancements in capacity and food production, and providing an adequate supply of nutritious

food. These projects and programs are made possible through funding from Hatch and Smith-Lever capacity grants, which provide the crucial support necessary to leverage and match external funding sources, resulting in more applied research, greater real-world applications of research, and better integration of research and Extension and Outreach.

Critical Issue: Community and Economic Development

Over half of Iowa farmland is owned by someone who does not currently farm. Of that land, 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 goes toward 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 Agriculture and Natural Resources specialists serve as an unbiased, research-based source of farmland leasing education. Program offerings included in-person and virtual options. Seventy-seven in-person programs had a total attendance of 1,235 participants and two virtual sessions were attended by 145 individuals.

Of the 1,380 participants who attended the educational programs, 297 were invited to complete a post-program survey. Survey responses indicated the audience consisted of non-farming landowners (71%), active farmers (15%), ag professionals (5%), and other attendees (9%). Approximately 90% of participants self-reported an increase in knowledge of leasing, legal issues, and/or cash rental rates. Ninety-eight percent reported an increase in confidence to create meaningful changes to their lease agreements.

Another community and economic development educational program is Women in Ag. Women have significant employment, management, and ownership on family farms and agribusinesses in Iowa. According to the Iowa Farmland Ownership and Tenure Survey 1982–2017: A Thirty-five Year Perspective, women own 47% of all Iowa farmland. Women across Iowa trust ISU Extension and Outreach's Farm Management Team to provide research-based information and tools to help them make good risk management decisions.

During the 2022 fiscal year, 21 different Women in Ag multi-session and eight stand-alone programs were held with 499 participants. After attending the various ag multi-session and stand-alone programs, participants reported the following:

- 86 of the 120 Annie's Project participants completed a post-course survey. 93% of the participants (n =80) self-reported an increase in knowledge in all areas of risk management and 99% (n = 85) self-reported taking at least two action steps in the areas of risk management.
- 61 attendees of the early career and beginning farmer sessions indicated they were going to take the action steps of creating farm business plans, developing farm resumes, scheduling family conversations, and meeting with ag lenders (FSA and other professionals such as legal and tax advisers).

City clerks in rural communities play an important role in supporting a community's economic development. The city clerk role is a demanding position with high staff turnover, particularly in rural communities. Low retention rates among municipal clerks result in a loss of knowledge of the laws, codes, and procedures needed to successfully operate municipalities. ISU Extension and Outreach community and economic development staff co-develop the Institute in partnership with the Iowa Municipal Finance Officers Association, and the Iowa League of Cities. The Iowa Municipal Professionals Institute (IMPI) effectively and efficiently onboards new local municipal professionals to ensure these individuals have the knowledge required to skillfully manage their municipal duties and apply expert knowledge to positively impact their communities.

During the 2022 Institute, a record 386 unique individuals attended and trained at IMPI, reaching all 100 Iowa agricultural extension districts. Each of the 386 participants had a 100% pass rate on all end-of-course tests. Within one year of completing the required educational courses needed for a clerk or finance officer certification track, approximately 28% (n= 108) of the 386 IMPI attendees obtained municipal clerk certification. Of the 108 attendees who obtained municipal clerk certifications, 61 of the recipients completed a post-certification survey indicating that as a direct result of obtaining their new professional certification:

- 41% self-reported a salary raise
- 8% self-reported a contract extension
- 2% self-reported a job title change or non-salaried benefit package

The COVID-19 pandemic has had severe impacts on the health, economic well-being, and emotional welfare of rural communities in the Midwest, particularly in Iowa. Rural areas with large senior populations, institutionalized residents, people with underlying medical conditions, and meat processing facilities have been particularly vulnerable. Rural communities also face socioeconomic challenges that limited their ability to respond to and recover from the pandemic, such as hospital and clinic closures, a lack of mental health services, and fewer non-profit organizations. The Iowa Small Towns Project surveyed nearly 13,000 households across 73 communities, including nine towns with large shares of persons of color. Results showed that COVID-19 had minimal impact on rural seniors but was experienced as a mental health issue for rural whites, a physical health threat for those with compromised health, and a major financial and health

emergency for rural people of color in Iowa, particularly in meatpacking towns. The data were used by stakeholders to prioritize programs and advocate for additional resources, target mental health programming to specific subpopulations in specific regions of the state, and determine financial needs and program utilization in meatpacking communities. The findings also highlight the need to address a trust gap among certain subpopulations and to communicate pandemic information effectively to specific subpopulations.

Secondary data from the American Community Survey and Current Population Survey were analyzed to understand the barriers to entrepreneurship faced by vulnerable populations, such as immigrants, racial and ethnic minorities, women, and rural communities. The project specifically looked at the impact of the COVID-19 pandemic on self-employment, which had a harsh impact on women, minorities, and self-employed individuals. The findings offer critical information for those developing policies and programs to consider as they work to benefit all groups, but especially the most vulnerable, during both health crises and normal times. The project also contributes to the body of research on barriers to entrepreneurship for minorities, rural communities, and women, which will better inform the public of the economic and social challenges faced during the pandemic.

Farmland accounts for the largest share of agricultural assets and is intrinsically linked to economic vitality in rural areas. According to a study investigating how experts update their farmland value estimates, agricultural professionals almost fully correct their prior "errors" in a single period and quickly incorporate changes in market price signals. The study, which analyzed data from the Iowa Land Value Survey (one of the most widely followed surveys of land values) from 2005 to 2015, found that experts' estimates are less informative and noisier for low-quality land, suggesting that more trust should be put in the survey for high-quality land values. To the best of researchers' knowledge, this study provides the first empirical investigation of the behavior of individual farmland value estimates collected through opinion surveys of market experts, making these results valuable for policymakers, agricultural professionals, and the general public.

Critical Issue: Food Production and Agricultural Systems

Crop simulation models help farmers to plan their management practices but require multiple input parameters and independent datasets to operate and verify performance. Researchers collected and analyzed relevant datasets, including maize leaf appearance rate and nitrogen leaching, from Iowa croplands. These data were used to improve the simulation models, resulting in a better understanding of how weather affects nitrogen leaching and how fast maize develops across the US Corn Belt, essential for developing predictive models for future climate scenarios. The research provides farmers with timely information to improve decision-making, and to provide policymakers and industry with new data and improved models to cope with climate change projections and sustainability assessments.

A recent study involving Iowa and Illinois soils has found that while surface soil organic carbon (SOC) stocks have been declining over time in agricultural systems, subsoil SOC stocks have been increasing, making subsoils important carbon sinks. Climate change may have contributed to this through increased precipitation causing wetter subsoils, which reduces soil organic matter decomposition. This is significant for agronomists and farmers because it highlights the need to maintain subsoil carbon storage by avoiding practices that increase subsoil water drainage, which can exacerbate greenhouse gas emissions.

Farmers are looking for crop production sustainability and profitability in Iowa and the North Central region that also minimizes water quality impairment. Studies revealed that in-season fluid potassium fertilization should not replace preplant fertilization for corn and soybeans. Application of single or annual pelleted lime rates lower than needed to increase soil pH to 6.0 or 6.5 limited crop yield significantly at most sites. Pelleted lime was found to be a superior source of effective calcium carbonate equivalent (ECCE) compared to aglime, with similar rates and time required for optimal soil pH and yield. However, it is more expensive, and producers should choose their lime source based on ECCE cost per unit.

Improving breeding processes allows for faster creation of climate and pest-resilient crop varieties. In support of this, researchers are working to develop novel approaches and train the next-generation workforce to increase the efficiency of the plant breeding process, focusing on maize, soybean, and sorghum. Specific areas of focus include improving the stress tolerance and nutritional quality of crops, developing an improved protocol for genetically transforming maize, and characterizing mutants of genes that have been shown to be important for maize adaptation and selection. Projects on maximizing genetic gains include the identification of genes that can increase haploid male fertility in crops for doubled-haploid line development and identifying ways to improve nitrogen production efficiency for soybean.

The soybean cyst nematode (SCN) is a significant threat to soybean crops in the US, causing an annual loss of approximately \$1.5 billion in yield. To combat this, experiments were conducted to determine the effectiveness of hundreds of SCN-resistant soybean varieties and 10 different nematode-protectant seed treatments. A list of SCN-resistant soybean varieties available to Iowa growers was compiled and published in October 2021. The findings of these experiments enable soybean farmers and agribusiness personnel in Iowa and other soybean-producing states to choose the most effective solutions for higher yields in both the short and long term.

Iowa's grain and feed cooperatives employ nearly 6,500 workers, pay over \$26.7 million in property taxes, operate in 618 locations and enroll over 129,000 members. As such, workforce development for these jobs is of great interest to the industry. The newly constructed ISU Kent Feed Mill and Grain Science Complex is set to be operational by mid-2023 and will provide crucial continuing education and advanced training and research for the grain handling and processing workforce. This is vital due to the high rate of retirements and a need for qualified professionals with advanced degrees in this field. The facility has already hosted short courses and tours, with over 500 visitors in 2022. Offering professional development and advanced technical training to grain and feed professionals not only prepares them for job-related responsibilities but also improves the quality of life and economic vitality of rural Midwest communities.

Corn production in Iowa is valued at \$9.87 billion. The Western corn rootworm impacts the profitability of every farm in Iowa given its resistance to all commercially available *Bt* cultivars, and therefore poses a significant threat to sustainable and profitable corn production. Findings from a 2020 Iowa corn insect pest management assessment indicated a lack of client knowledge on identification, scouting, and best management practices for corn rootworm. It is critical to educate farmers on corn rootworm biology and research-based crop protection strategies, in addition to providing recommendations for long term, profitable decision making. As a result, twelve ISU Extension and Outreach agronomists and entomologists developed hands-on demonstrations across Iowa in 2022. This hands-on learning approach allowed participants to observe and learn detailed methods for sampling corn rootworm and evaluating management tactics that are difficult to convey in a lecture setting.

Participants completed a post-pre survey that assessed participants' knowledge before and after the hands-on demonstrations. Eighty-two percent of participants, up from 36% pre-demonstrations, self-reported an increase in confidence in identifying Northern and Western corn rootworm adults following the demonstrations. There were also significant improvements in confidence in recognizing and rating root injury from corn rootworm larvae. Following the event, 49% of people self-reported high confidence compared to 13% prior to the event. Participants gained a better understanding of the complexity of effective corn rootworm management. The number of people reporting a high level of concern for effective management with *Bt* was raised from 38% to 60% following the demonstrations. Of the 29 respondents that indicated they were farmers, 55% planned to make management changes next year with the information they learned from the demonstration. Nearly half (48%) of farmers expected to see a \$5-10/acre increase in profits with the information gained from the demonstration. These farmers reported growing 3,788 acres of corn in 2022. 21% of farmers expected between \$11-20/acre more in profit following the demonstration (1,180 corn acres in 2022), and 10% expected an increase of more than \$20/acre (1,150 corn acres in 2022).

In another evaluation (2018) of approximately 1,000 respondents engaged in Iowa Beef Center extension grazing programs, nearly 80% of those surveyed indicated they incorporated cover crops (winter annuals) into their farming enterprise. Respondents also wanted more research on cropping systems incorporated with cattle production, including the long-term benefits of adding small grains into the rotation, double cropping cool-season forages with summer forages, and altering cropping rotations to incorporate grazing into the enterprise. Incorporating a summer annual into the crop rotation provides needed mid-summer forage grazing while taking limited row crop acres out of production. A winter annual/summer annual forage rotation disrupts the traditional corn/soybean rotation to reduce pest pressure, rotate pesticides, and scavenge soil nutrients; provides enterprise flexibility on the farm; and provides feed supplies during three critical seasons when perennial pasture production is insufficient.

Iowa State University Extension and Outreach Beef Specialists and Field Agronomists collaborated to develop and deliver a multi-faceted extension program to reach cow-calf producers regarding the benefits of adding winter or summer annual forages into grazing systems. On-farm demonstration field days were held at 15 statewide locations and information was presented at 15 additional meetings directly reaching 732 producers.

A field day evaluation card was distributed at eighteen field days or presentations with over 270 attendees to measure immediate knowledge change and intentional action changes. A follow-up evaluation was also mailed to 217 of the 270 participants to measure longer-term knowledge change and adopted practices. Using post-event evaluations, 88% of participants (107/121) reported an increase in knowledge in one or more of the five knowledge indicators related to annuals' environmental benefits, yield and nutritional differences, selection of annual species, economics for crop rotation, and economics for feed. Sixty percent of participants (35/58) reported making one or more changes to their operation involving annual forage production, and on average made three changes to their forage operation. Sixty-six respondents who had experience with annual forages anticipated that annual forages would provide about 68 fall grazing days, 47 spring days, 52 summer days, or 64 winter days. The weighted average return per acre was \$3.91/acre for those who attended a program. Utilizing winter annuals followed by a summer annual provides additional forage for grazing, reducing grazing costs (a week of additional grazing reduces the stored feed bill by \$15 per cow), improving local economic conditions, and improving soil health, which leads to improved water quality and resiliency to extreme weather events.

Critical Issue: Health, Nutrition and Well-being

A research project examined the factors influencing the health and well-being of rural Iowa Latinx immigrant families, a segment of the population that contributes significantly to Iowa's agriculture and food production economies. To date, 432 interviews were conducted with Latina/o immigrant parents across six Iowa communities to gather data related to food security, depressive symptoms, financial stress, employment status, and COVID-19. Findings indicated that low-income Latinx families with young children face disadvantages in child health, access to healthcare, and food insecurity. Clinically significant depressive symptoms among Latina mothers were related to transportation, health insurance, healthcare access, and to food insecurity. First-generation immigrant mothers have lower levels of acculturation, which may serve as a protective factor against depression and food insecurity when compared with US-born Latina mothers. The study also found that faith; emotional and tangible support from family members, friends, and local churches; and adhering to health advice helped to safeguard families' health and well-being during the pandemic.

Another research project aims to reduce economic hardship, family stress, and negative health outcomes in rural Iowa families. Findings could broadly impact the 46 million people living in rural areas in the US. Rural communities have higher poverty rates and lack access to healthcare, leading to poorer health outcomes. Additionally, food insecurity rates are higher in rural communities, which exacerbate health outcomes. The Family Transitions Project, a 3-generation study of rural Iowa families, provided the data to examine the association between economic adversity, emotional distress, negative family processes, and health outcomes across the lifespan. The findings showed that intergenerational transmission of economic adversity, BMI, and emotional distress, the detrimental and long-lasting effect of felt economic pressures on personal and marital distress in middle adulthood, and the importance of family support and individual resilience in emerging adulthood can ameliorate the negative continuity of emotional well-being over time. The research also highlights the unique family and intergenerational processes affecting psychological well-being and externalizing behaviors over the lifespan, with a focus on alcohol problems and psychiatric disorders across two generations. This study is one of the first to quantitatively explore older adults' simultaneous positive and negative feelings toward their siblings and found its association with older adults' emotional distress, showing that sibling relationship quality matters to psychological well-being in later adulthood.

Over 10,000 older Iowans participated in community education and/or research programs aimed at promoting health and well-being, resulting in better nutrition choices and a better understanding of food security resources, healthy lifestyle practices, and SNAP awareness. The programs included an online healthy aging series with 321 participants that led to a significant increase in familiarity with recommended lifestyle practices, and a commodity and supplemental food nutrition education program that reached about 4,000 older Iowans and helped them make better food choices, apply budget tips, and make recipes at home. The information gathered from the needs assessment project is also informing the creation of materials distributed nationally by the Nutrition and Aging Resource Center.

In the United States, it is estimated 48 million people experience a foodborne illness each year, 128,000 people are hospitalized due to a foodborne illness, and 3,000 deaths result 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. ServSafe® training was provided by ten Human Sciences Food and Health Program Extension Specialists. Over 2,018 Iowans participated in an 8-hour Servsafe® workshop regarding safe food handling practices. A total of 250 Servsafe® trainings were facilitated.

Of the 2,018 participants who completed ServSafe® training, 1,418 (70.3%) of the participants were successful in passing the class and received food safety certification through the National Restaurant Associations' Servsafe® Program. 70.3% (n=1,418) of participants self-reported an increase in knowledge of food safety and safe food handling procedures. By training foodservice workers to learn how to safely handle food, Iowa consumers are protected from getting food poisoning, potentially preventing serious illness or death.

Critical Issue: Human Potential and Youth Development

Misinformation 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 refunds. Inaccurate tax filings can result in unexpected penalties and a large tax bill. A trained tax preparer can help Iowans avoid missteps; however, the average tax preparation fee was \$220 in 2022, making these services unaffordable to many Iowans. The Volunteer Income Tax Assistance (VITA) program provides free, accurate, and trustworthy tax preparation to families with low to moderate incomes. In FY22, three Human Sciences Extension staff trained and supported 128 community volunteers who successfully completed IRS certification examinations for tax preparation. VITA programs were offered at 17 county extension offices reaching 2,450 Iowans with free and accurate tax preparation, and access to critical tax credits.

- 8,955 volunteer hours of tax preparation services were provided equaling approximately \$236,412 (Independent Sector, Value of Volunteer Time, Iowa, 2023)

- 810 tax returns contained Earned Income Tax Credit (EITC) requests equaling \$1,158,003 in EITC refunds
- \$4,478,637 in total refunds were secured
- \$666,400 in tax preparation fees were saved

According to the National Alliance on Mental Illness (NAMI), 42.2% of Iowa adults reported symptoms of anxiety or depression (NAMI, 2021). Similarly, NAMI reported that one in six youth aged 6 to 17 experience a mental health disorder each year. In Iowa, 37,000 youth ages 12 to 17 reported having depression. Stressors related to the COVID pandemic also played a role in the number of youth who indicated struggling with their mental health. A 2020 survey conducted by Harris Poll, and commissioned by the National 4-H Council, found that 7 in 10 teens are struggling with mental health in the wake of COVID-19. This study also found that 55% of teens say they have experienced anxiety, 45% excessive stress, and 43% depression.

Iowa State University Extension and Outreach's implementation of the evidence-based Mental Health First Aid (MHFA) and Question.Persuade.Refer. (QPR) programs provide Iowans with critical information related to risk factors and warning signs of potential suicide. The programs teach Iowans about mental health and substance use concerns and how to actively engage in helping others with mental health concerns. Seventeen Human Sciences, 4-H Youth Development, and Agricultural and Natural Resources extension program specialists were engaged as facilitators. They reached 534 participants in 33 virtual or in-person workshops. Eight Human Sciences, one Agriculture and Natural Resources, and three county extension educators and specialists were engaged as QPR facilitators. They reached 823 participants in 50 virtual or in-person programs.

Through post-program surveys, QPR and MHFA participants indicated:

- QPR Results: 98.4% of program participants (616/626) rated their knowledge of, "How to ask someone about suicide" as medium or high
- MHFA Results: 74.7% of program participants (86/115) agreed or strongly agreed they could ask anyone whether they were considering killing themselves
- QPR Results: 98.3% of program participants (618/629) rated their knowledge of local resources for help with suicide prevention as medium or high
- MHFA Results: 69.6% of program participants (80/115) noted it was likely or extremely likely that sharing knowledge of local resources would help with suicide prevention
- QPR Results: 99.4% of program participants (622/626) rated their knowledge of, "How to get help for someone," as medium or high
- MHFA Results: 60.9% of program participants (70/115) indicated it was easy or very easy to refer someone experiencing a mental health or substance use challenge(s) to a health professional

According to the 4-H Youth Mental Health Survey administered by the National 4-H Council in 2020, 82% of youth wished America would talk more openly about mental health. Also in 2020, a Center for Disease Control and Prevention study indicated rates of suicide among youth and young adults ages 10-24 increased by 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).

Mindful Teen: From Surviving to THRIVING! is a six-session curriculum based on a book written by Dr. Dzung Vo (2015). The curriculum helps youth foster mindfulness skill development and thoughtful reflection while aiming to reduce youths' stress and risk of mental illness. Twenty-six ISU Extension and Outreach 4-H staff, volunteers, and school and community partners facilitated the sessions. The Mindful Teen program was implemented in Iowa reaching 300 teens.

Sixty youths completed a post-program survey. Survey findings indicate:

- 90% of youth (54/60) self-reported they "Strongly Agree or Agree" that they have a better understanding of how stress impacts their mental and physical state
- 63% of respondents (38/60) self-reported they "Strongly Agree or Agree" that mindfulness practices can help them create and maintain positive relationships with people. 78% of youth reported (47/60) they believe mindfulness practices can help their overall well-being. Two-thirds of post-program survey respondents (40/60) stated that as a result of engaging in the 4-H Mindful Teen program, with practice they believe they can better cope with stress and difficult emotions

According to the Governor's Child Care Task Force Report (2021), Iowa estimates that the childcare shortage costs the state \$935 million annually in lost tax revenue, absences, and employee turnover. 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. In FY22, 100,079 total class certificates of completion were issued to Iowa early childhood teachers and providers for successfully completing at least one of the 12 Essentials to Child Care Program's online classes. Participation in the Essentials to Child Care Program has been added to state licensing requirements for all Iowa child care teachers 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.
Increased knowledge on how to create safe environments for young children.

As measured on a post-course certification exam,

- 100% of participants (n = 8,930) self-reported an increase in knowledge of how to create safe environments for young children
- 100% of participants (n = 8,626) self-reported an increase in knowledge of emergency preparation
- 100% of participants (n = 8,478) self-reported an increase in knowledge of how to transport children safely
- 100% of participants (n = 8,378) self-reported an increase in knowledge of the prevention, and control of infectious disease
- 100% of participants (n = 8,220) self-reported an increase in knowledge of reducing hazardous materials
- 100% of participants (n = 8,433) self-reported an increase in knowledge of medication management for children in child care
- 100% of participants (n = 8,139) self-reported an increase in knowledge of preventing and managing food allergy reactions in young children
- 100% of participants (n = 8,023) self-reported an increase in knowledge of infant-safe sleep and the prevention of Sudden Infant Death Syndrome
- 100% of participants (n = 8,759) self-reported an increase in knowledge of the prevention of Shaken Baby Syndrome
- 100% of participants (n = 8,024) self-reported an increase in knowledge of supporting cultural diversity
- Increased knowledge of Understanding Homelessness
- 100% of participants (n = 8,014) self-reported an increase in knowledge of understanding homelessness
- 100% of participants (n = 8,055) self-reported an increase in knowledge of child development

Critical Issue: Natural Resources and Environmental Stewardship

Intensive crop production in Iowa contributes to local and downstream water quality issues, but one research project has identified some solutions. Controlled drainage and subsurface denitrification bioreactors were found to reduce nitrate-N loss to downstream waters. Saturated buffer sites were shown to be 18%-98% effective in removing nitrate from tile drainage. This has provided underpinnings for the rapid adoption of the practice throughout the drained landscape in the Midwest. Technology transfer efforts at multiple scales have translated the research into the scaled-up implementation of these practices in priority watersheds involving strong public-private partnerships. In addition, intensively monitored research sites now cumulatively provide 90 site years of data that document the effectiveness of nitrate removal by saturated buffers.

Two decision support tools, the Financial and Nutrient Reduction Tracking tool (FiNRT) and the Conservation Optimizer (CON-op), have been developed to aid conservation planners in incorporating economic information into conservation planning and watershed projects. The FiNRT assesses nitrate-N loss reduction and estimates the direct and relevant opportunity costs of various best management practices, while the CON-op determines the most cost-effective combination of practices to achieve water quality goals. These tools are the only ones of their kind available to conservation planners in the US Cornbelt region and have been released as part of the broader Agricultural Conservation Planning Tool (ACPF) related programming. The use of these tools could lead to the development of more appropriate budgets and optimal allocative pathways regarding available resources, which is particularly critical when financial and technical service resources are scarce.

A research project focused on the impact of nitrogen fertilization on microbial biomass, nitrogen-cycling enzymes, and soil properties in annual maize and perennial *Miscanthus* cropping systems. Researchers found that nitrogen fertilization did not affect microbial biomass in either cropping system, and plantings of *Miscanthus* increased water-holding capacity and soil organic matter compared to maize. Soil pH and clay concentration were found to have a greater impact on enzyme activity than nitrogen fertility alone. Researchers also developed a new method to estimate soil water retention curves. These findings will improve models used by soil scientists and conservationists to predict changes in soil properties resulting from agricultural activities. This will allow farmers and land managers to make better decisions in optimizing their practices for long-term sustainability.

Implementation of the Multiple Species Inventory and Monitoring (MSIM) program allowed for surveillance of Iowa's wildlife to understand how it responds to local and landscape habitat conditions. This work has important implications for habitat management and survey methodologies to benefit Blanding's Turtles and Monarch butterflies in Iowa. In addition, advice was provided on managing flood storage reservoir water levels to benefit migratory shorebirds and other waterbirds under the Sustainable Rivers Program (SRP), a cooperative effort between the U.S. Army Corps of Engineers and The Nature Conservancy. Research on wildlife use of wetlands constructed for water quality dovetails with ongoing efforts to address systemic challenges of nutrient pollution in surface waters throughout the corn belt. Conservation research outcomes continue to have broad impacts on how Iowa's wildlife is conserved and managed for the enjoyment of future generations.

Researchers examined lymphoproliferative disease virus (LPDV), newly identified in wild turkeys in Iowa, and found that the long terminal repeat region of the viral genome is a better choice for LPDV surveillance than a region called gag, which is the primary region used in published studies. Additionally, the research identified a high diversity of LPDV strains in Iowa, indicating the virus has likely been present for a considerable period of time, and may be related to declining wild turkey populations. The findings provide valuable knowledge for natural resource managers and researchers, allowing for more effective surveillance and potentially aiding in understanding the virus' impact on wild turkeys.

In Iowa's 2020 impaired water listing, only 1% of assessed water segments 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 water bodies.

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. Agriculture and Natural Resources Extension Specialist facilitate the Iowa Watershed Academy twice annually to support current watershed coordinator and conservation practitioner needs.

In 2022, the Spring 2022 Academy was attended by 36 coordinators and conservation professionals and focused managing perennials on farmland for the benefit of habitat, wildlife and profitability. It also included presentations on persuasive communication and working with the media. The Fall 2022 Academy was attended by 35 coordinators and conservation professionals and focused on soil and nutrient management, machinery, and working with partners. Pre and post self-assessments were completed by 39 participants. At both academies, 95% of attendees who completed the surveys indicated an increase in knowledge related to conservation practices, programs, and outreach strategies and stated they would share information learned with colleagues. Seven attendees signed up to be members of the Watershed Academy Advisory Council and ten watershed coordinators were accepted into the Land Stewardship Leadership Academy.

Prudent management of natural resources and sustainable conservation practices are necessary for maintaining and supporting healthy ecosystems within Iowa. 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. In 2022, the Master Conservationist Program offered 17 courses that were attended by 252 participants. The courses were organized and led by a state extension wildlife specialist, a natural resources field specialist, and 24 extension districts with support from local conservation organizations. A total of 7,812 educational contact hours were provided. Each course topic was addressed in an online module followed by an in-person field day.

Pre-course and post-course assessments were completed by 121 participants to predict the impact of the program on changes in land use and resource stewardship behaviors. All 121 participants reported an increase in knowledge of prairie forest and aquatic ecosystems, conservation practices in Iowa, and increased confidence in their ability to communicate natural resources knowledge and practices to others. 97% of respondents replied they planned to apply lessons learned to land they owned or had influence over. 84% of respondents indicated they intended to apply lessons from the class to their "home yard or farmstead." These respondents reported an intent to impact 1,161 acres of home yards and farmsteads. Respondents also stated an intent to impact a number of other land uses including aquatic ecosystems (41% of respondents, 691 acres), city parks or public natural areas (34% of respondents, 6,230 acres), cropland (20% of respondents, 3,906 acres), forested areas (39% of respondents, 893 acres), pasture (28% of respondents, 937 acres), prairie areas (39% of respondents, 556 acres), and other land uses (5% of respondents, 5 acres). In total, respondents indicated an intent to impact 14,379 acres of land with lessons learned from the class.

Critical Issue: Transformative Technology

Implementing precision conservation practices helps farmers to maximize productivity and environmental benefits while minimizing economic investments. This year, progress has been made in incorporating knowledge of agricultural production systems into machine systems for improved performance. Innovations include sprayer control systems, tillage depth adjustment, and cotton harvest quality and efficiency. The Soil Machine Dynamics Laboratory and the Off-highway Vehicle Chassis Dynamometer Laboratory are two new facilities that have been developed to improve the validity and reliability of models to provide a better functional understanding of the soil-crop-machine interaction associated with agricultural machines. In addition, new improvements were made to the PhenoBot; the ISU-developed state-of-the-art image-based platform for phenotyping tall biomass crops to generate large datasets of plant architecture traits during the entire growing season. This year's improvements and additions included adding an antenna mast for improved GPS positioning and a redesign of the PhenoStereo 3D stereo vision module to improve reliability. In addition, a preliminary algorithm was built for maize plant leaf area sensing and soybean plant seed pod characterization. A cyber-enabled environment was developed that integrates Lidar sensing data with advanced data analytics and modeling tools to advance the planning, implementation, and adoption of precision conservation management at field and landscape levels. The success of PhenoBot 3.0 development provides an automated unique and enabling solution for field-based phenotyping of row crops, particularly tall-growing crops like maize and sorghum.

Researchers have developed new genomic information for pigs and cattle that will enable gene function annotation for both species. The functional analysis of the pig genome included the development of genome assemblies of pig genomes used for the Functional Annotation of Animal Genomes (FAANG) project. These assemblies were compared to the current reference assembly and showed high assembly completeness. The researchers also used new technology to sequence RNA in individual cells and found that the similarity of gene expression patterns correctly aligns with different immune tissues, enabling the prediction of which variants control gene expression in specific cell types from whole-blood samples. In the natural disease challenge project, immunological and hematological assays were carried out, and several measures had both substantial heritability and genetic correlations with traits related to resilience. In the cattle project, a multi-omics approach was used to identify 171,985 unique transcripts, including 35,150 unique genes. Approximately 50% of the protein-coding genes were transcribed as both coding and noncoding transcripts. These validated results show significant improvement over current bovine gene and transcript annotations, extending the boundaries of more than 11,000 known genes compared to Ensembl or NCBI annotations. Key outcomes include the development of new high-quality genome assemblies for pigs, the identification of immune response gene expression patterns by tissue type based on simple blood samples from pigs, and the identification of novel transcripts and extension of the boundaries of known genes in cattle.

Body condition evaluation through digital image capture could be used as a cumulative indicator trait to assess a sow's lifetime welfare status, with associated images providing valuable feedback to producers by providing individual or group average sow body condition score (BCS) after culling. Toward enabling these technologies, a study assessed the accuracy and reproducibility of digital images in evaluating cull-sow BCS at a Midwest cull-sow abattoir. The ability of scorers to accurately identify sows with low BCS and predict trim loss in carcasses was tested. Scorer agreement ranged from 88% to 97%, suggesting consistent scoring of body condition scores. The study indicates that digital images obtained immediately before harvest are acceptable methods to assess cull sow BCS. Digital imagery can be used to provide producers and harvest facilities with feedback on cull-sow conditions, improve economic value, and purchase the appropriate cull-sow blend to produce desired final processed products. The use of digital images to monitor body condition, behavior, and welfare-related traits, along with infrared thermography, offers the potential to detect locations for carcass trimming before post-mortem inspection. The Johnsonville plant where this work was conducted has implemented the digital imagery system in their daily operations (~850 sows per day). Johnsonville is the number one national sausage company.

Merit and Scientific Peer Review Processes

Updates

None

Stakeholder Input

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

In August 2022, ISU Extension and Outreach engaged in its first statewide survey to assess Iowans', ages 18 and older, preferences for accessing, receiving, and engaging with extension learning experiences – both in person and virtually. The survey was available in English and Spanish. The survey was distributed across Iowa using two methods. The first method was using Qualtrics market research panels. Using Qualtrics panels, 1,118 surveys were collected. The second method was sharing the survey URL through ISU Extension and Outreach's media and network channels. One thousand five hundred sixteen individuals completed the survey using this method.

Methods to identify individuals and groups and brief explanation

The survey was distributed across Iowa using two methods. Based on Iowa demographic data from the US Census Bureau (2021), the two-method approach was intentionally implemented to align as close as possible to Iowa's demographic data across the variables of ethnicity, race, gender, age, and household income. The first method was using Qualtrics market research panels. Using Qualtrics panels, 1,118 surveys were collected. The second method was sharing the survey URL through ISU Extension and Outreach's media and network channels. One thousand five hundred sixteen individuals completed the survey using this method.

Methods for collecting stakeholder input and brief explanation

The *Iowa Preferences for Receiving, Accessing, and Engaging in Education* survey is the first statewide assessment supported and funded by ISU Extension and Outreach central administration using two-methods for survey distribution. Using data-informed decisions, survey findings will guide ISU Extension and Outreach in prioritizing outreach efforts to align with Iowans' preferences/interests in educational content, delivery methods of educational content, use of technology platforms, and branding and marketing of ISU Extension and Outreach's portfolio of informal educational learning experiences.

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

Given access to the *Iowa Preferences for Receiving, Accessing, and Engaging in Education* survey recently closed on March 31, 2023, qualitative and quantitative survey data has not yet been analyzed. Overarching survey findings will be included in the FFY23 annual report.

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



2022 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.

Planning for farmland leasing programs begins months in advance. Program preparations include reviewing materials, planning meeting sites with county staff partners, and developing the objectives for the program based on previous feedback from participants and current issues that will impact the next crop year. In 2021, with uncertainty remaining regarding COVID-19 recommendations, program offerings included in-person and two webinar options.

Evaluation comments from the prior year's meeting evaluations are used in the program development process. This gives insight into the needs of the clientele for the core curriculum of the program along with rising issues to include where suitable. As preparations began for the Farmland Leasing and Management Workshops held in July and August 2021, an assessment of growing issues were observed relating to: increased interest of land as an investment, both by purchase or retaining after inheritance, increases in land values close to what was observed in 2012-2013, questions and interest in carbon markets and how those programs fit in with leasing arrangements. These programs returned to a more normal offering, coming out of the pandemic, but the impacts of the pandemic were clear with record government support, historically low interest rates, and surging agricultural exports that led to hefty increases in farmland values for almost all Midwestern states.

Prior to leasing meetings, online leasing publications and tools were reviewed, including the well-known Iowa State University Cash Rental Rate Survey (FM 1851). These materials are integrated into the core curriculum of farmland lease meetings. Having a presence online is also vital throughout the year to serve as a reliable source of information on the web and reach clients who are out-of-state or may not attend traditional in-person events.

77 in-person sites (compared to 31 in 2020) had total attendance of **1,235 participants**, averaging 16 people per location. Total attendance was higher than the 496 in-person attendees from 2020, but average meeting attendance remained the same. Additional planning continued with county partners that included rearranging locations to allow social distancing or finding a new, larger location to hold the program and limiting attendance. Two sessions were offered virtually through a GoTo webinar. The virtual sessions were attended by 145 individuals. In addition to planned educational events, direct questions to Farm Management Extension field and campus specialists require significant time answering client's specific questions via phone, email, and office visits. The topic of farmland ownership and tenancy is embedded in Farm Management programming throughout the year.

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

Follow-up responses to a Qualtrics survey from **297 attendees** showed the audience consisted of non-farming landowners (71%), active farmers (15%), ag professionals (5%), and other (9%). As this program is held annually, participants are often repeat attendees, with 59% having attended at least one program in previous years.

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

- o Leasing = 91%
- o Legal Issues = 93%
- o Cash Rental Rates = 86%

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

- o 98%

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.

- o 92%

The changes made year-to-year to leasing arrangements vary for a multitude of reasons, and a point of focus during programs is that each party must recognize how their lease may be unique and make the changes that fit best their situation. Lease changes aren't always the best course if the agreement in place fits for all parties. As there are often a range of reasons for attendance, participants are asked their level of satisfaction with the program. 287 of 292 responses (98%) were very satisfied or satisfied the program met their expectations.

- o "I wanted to pass along a quick thank you for some of YOUR [materials] I referenced online... it proved to be the MOST HELPFUL resource I found ... It really helped steer me in the right direction to locate the resources I needed and also helped me better prepare for a meeting"
- o Thank you again for your input and the detailed explanations... I can not thank you enough for all your time!
- o Thank you so much for having the Oakland, IA, Farmland Leasing and Management Workshop during the day in late July! That helps out so very much! I am so thankful to receive email notification about this prior to the day as well!
- o Thank you, also, for the updates for the fencing, hunting, and most importantly, the Farmland Lease Annual Report! Oh my goodness, that will help me out so very much! And, much to my surprise, my Tenant agreed it would be a good idea to fill out the Annual Report Form!
- o You did a great job with the meeting. I just can't thank you enough or express how much all this information has helped me!
- o Please take good care of yourself! Blessings to you and your family as well!

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

Farmland is the limited resources for producers in Iowa. With an aging landowner population and issues related to farmland changing year after year, leasing programs and materials are of great value to the clientele in our state and the Iowa landowners scattered across the country. Land changes hands for many reasons, and becoming a landowner can be unexpected for some. Without the prior generation to serve as a guide, resources from Iowa State University can provide guidance in an overwhelming situation. In negotiations that can be tense at times, ISU Extension and Outreach serves as an unbiased, research-based source of education. This leads to an increased ability for our clientele who impact local economics across the state to successfully endure the cyclical nature of agriculture and benefits all Iowans by creating stronger rural and urban economies.

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.

Plastina, A., A. Johanns. "Cash Rental Rates for Iowa Survey," Ag Decision Maker, File C2-10, May 2022. Downloads: 70,000

Plastina, A., A. Johanns. "Historic County Cropland Cash Rental Rates," Ag Decision Maker, File C2-11, June 2022. Downloads: 1,261

Leibold, K. "Improving Your Farm Lease Contract," Ag Decision Maker, File C2-01, July 2022. Downloads: 537

Johanns, A. "Iowa Farmland Rental Rates 1994-2021 (USDA)," Ag Decision Maker, File C2-09, August 2021. Downloads: 1,230

O'Rourke, M. "Farmland Lease Annual Report," Ag Decision Maker, File C2-06, July 2022. Downloads: 1,397

Municipal Professionals Institute

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7001649



2022 Iowa Municipal Professionals Institute

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

The city clerk role is a demanding position with high staff turnover, particularly in rural communities. Low retention rates among municipal clerks results in a loss of knowledge of the laws, codes, and procedures needed to successfully operate municipalities. The Iowa Municipal Professionals Institute (IMPI) effectively and efficiently onboards new local municipal professionals to ensure these individuals have the knowledge required to skillfully manage their municipal duties and apply expert knowledge to positively impact their communities.

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.

IMPI offers instructional sessions yearly which include a variety of courses to assist municipal professionals in their day-to-day duties, including the keeping of public records and for any other purpose deemed to be in the best interest of the public. Sessions are held three times per year. Two of these sessions are offered virtually (February and October), one session is offered in-person (July in Ames, IA). Each of these three sessions has a unique catalog of courses. There are approximately thirty unique courses spread across the three sessions and each unique course is offered only once per year. Attendees of these sessions can choose to sign up for courses depending on their schedule and certification track. For the 2022 sessions, a record **386** unique individuals attended and trained at IMPI, reaching all 100 Iowa counties.

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

Each of the **386** participants had a **100% pass rate** on all end-of-course tests. Within one year of completing the required educational courses needed for a clerk or finance officer certification track, there were **107 total certifications** out of the 386 IMPI attendees.

- **27.7%** of total IMPI attendees received municipal clerk certification, surpassing the original stated goal of 20%.

A sample survey was also sent to the individuals who newly received certifications in the 2022 reporting year. Of the 61 recipients who received the survey, we had a 57.1% response rate. The results show:

- Of those surveyed, **50.81%** self-reported a **salary raise, contract extension, job title change, or non-salaried benefit package change** as a result of their professional certification. The original identified goal was to achieve an overall self-reported change in life situation of 50%.
 - **40.98%** reported a **Pay Raise** as a result of certification
 - **8.20%** reported a **Job Title Change** as a result of certification
 - **1.64%** reported an **Other Change** as a result of certification

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

Improved knowledge and skill of municipal professionals leads to improved performance in their work to assist citizens. More knowledgeable and skillful employees in local government can reduce instances of fraud, improve performance in the handling of local elections, and reduce friction in the delivery of government services.

Women in Agriculture

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7001417



2022 Women In Agriculture

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

Women have significant employment, management and ownership on family farms and agribusinesses in Iowa. The 2017 Census of Agriculture reported 49,085 women farm operators, representing 34% of all farm operators in Iowa. 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. Women comprise more than half of the undergraduates in the Iowa State University (ISU) College of Agriculture and Life Sciences representing 57.7% for the 2022 academic year. Women across Iowa trust ISU Extension and Outreach to provide research-based information and tools to help them make good risk management decisions. The Farm Management team has an important role in providing effective and efficient education for women 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.

During the 2022 fiscal year, 21 women in ag multi-part sessions and eight stand-alone programs were held with 499 participants.

The statewide in-depth, multi-part sessions offered to the 499 individuals included:

- **Annie's Project:** 4 courses, 18 contact hours per course
- **Women Marketing Grain:** 1 course, 12 contact hours per course
- **Advanced Grain Marketing for Women:** 1 pilot course, 12 contact hours per course
- **Managing for Today and Tomorrow:** 1 course, 15 contact hours per course
- **Women Planning Ag Businesses:** 1 course, 15 contact hours per course
- **Women Managing Farm Finances:** 1 course, 12 contact hours
- **Women Managing Horses:** 1 course, 8 contact hours per course
- **Early Career & Beginning Farmer Workshops:** 5, 2-part sessions, 6 hours per session

Single session programs included:

- **Women Managing Farmland:** 7 pilot sessions, 3 contact hours per session
- **Benchmarking Family Living:** 1 stand-alone session (also included in the multi-session Annie's Project)
- **Beginning Farmer** focused programs on multiple topics: 8 sessions

In addition to multi-session programs, a statewide leadership conference was held in November 2021, "*Lead like someone left the gate open*". The conference committee goals were to offer a women-centered program that replenishes spirits and deepens aspirations to lead within families, communities and across the global agricultural industry. The two-day, in-person event included campus tours and industry leaders facilitating multiple sessions over the 14-hour program with **113** men and women

attendees. This annual event included awards for Women Impacting Agriculture, with two honorees. Comments from these women highlighted the impact Iowa State University Extension and Outreach had over the course of their careers, specifically highlighting their attendance at an Annie's Project and its impact in increasing their farm business management skills.

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

86 of the 120 Annie's Project participants completed a post-course survey. 93% of the participants (n =80) self-reported an increase in knowledge in all areas of risk management and 99% (n = 85) self-reported taking at least two action steps in the areas of risk management. In addition to the outcome measures reported above, action steps from the 61 attendees at the early career and beginning farmer sessions included: creation of business plans, development of farm resumes, scheduling of family conversations, and meeting with ag lenders (FSA and IADA representatives) and other professionals (legal and tax advisers).

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

93%

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

99%

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

100%

Evaluations from the pilot "Advanced Grain Marketing Course" showed likely actions of the 10 respondents:

- After completing the course 80.0% of respondents 'definitely plan to do' or 'maybe will do' choose an options or options backed strategy that can be appropriate for my farm.
- After completing the course 70.0% of respondents 'definitely plan to do' or 'maybe will do' apply a new marketing strategy on my farm.
- After completing the course 70.0% of respondents 'definitely plan to do' or 'maybe will do' talk with a classmate or ISU Extension about marketing strategies.
- After completing the course 70.0% of respondents 'definitely plan to do' or 'maybe will do' talk with a farmer cooperative or grain merchandiser about marketing strategies.

Additional comments from course evaluations and direct feedback from attendees:

A regular program attendee and Extension client commented, "I would not be who I am today and where I am at in relation to agriculture without your support. Many thanks, too, for the special support as I learn more about agriculture influences..."

This is an amazing conference that always seems to come about when I personally need to verification that I am doing a good job in my profession and that there are other women to network with and support!

[The most important thing I learned during Annie's Project...] EVERYTHING - it sounds cliché, but I will utilize all the topics whether I considered myself an expert coming in or not, I learned something I will be able to share with individuals looking for more information.

[Changes I will make to my human resources practices to improve profitability...] seek answers to a lot more questions. Not being afraid to ask questions and learn more about different programs.

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

Women in the agricultural industry are key stakeholders in the production of safe, plentiful, and accessible food. There is a critical need for education directed specifically to women in agriculture to help them confidently make better decisions for their businesses. When women access research-based information, education and support through ISU Extension and Outreach, they can take on influential roles to improve farm profitability and the rural economy; increase conservation practices, improve water quality, enhance family and community networks, and leadership for a stronger Iowa.

Agricultural and Rural Finance Markets in Transition

Project Director

Sergio Lence

Organization

Iowa State University

Accession Number



Expert Opinions of Land Values

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

Institutions such as land grant universities, Federal Reserve banks, professional societies, and the U.S. Department of Agriculture (USDA) conduct periodic surveys of producers or agricultural professionals to measure current market conditions. While USDA surveys sample agricultural producers, most other opinion surveys rely on agricultural “experts” or professionals, including real estate agents, rural appraisers, agricultural lenders, farm managers, and county assessors. Interestingly, in spite of the wide use of opinion surveys and the attention they receive, little is known about the behavior of individual experts’ opinions over time.

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 a paper published in *Land Economics*, we investigate how surveyed experts update their farmland value estimates using a panel data of 311 agricultural professionals from the Iowa Land Value Survey from 2005 to 2015. We find that experts almost fully correct their prior “errors” in a single period. Experts’ opinions also incorporate most of the prevailing price innovations in one period. Our Bayesian estimation technique simultaneously addresses the non-stationarity of farmland values and the Nickell bias in short dynamic panels.

Reference

Zhang, W., **S.H. Lence**, and T. Kuethe. “Are Expert Opinions Accurate? Panel Data Evidence from the Iowa Land Value Survey.” *Land Economics* (forthcoming). DOI: 080820-0124R

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

To the best of our knowledge, this study provides the first empirical investigation of the behavior of individual farmland value estimates collected through opinion surveys of market experts. The ISU Land Value Survey analyzed is one of the most widely followed surveys of land values. The empirical results provide strong evidence that experts’ estimates conform to an ECM in which they quickly self-correct prior errors and almost instantaneously incorporate changes in market price signals. However, experts’ estimates are found to be less informative and noisier for low-quality land, suggesting that more trust should be put in the ISU Land Value Survey for high-quality land values than for low-quality land values.

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

Farmland accounts for the largest share of agricultural assets and is a major source of collateral. As such, the value of farmland is intrinsically linked to economic vitality in rural areas. A better understanding of the behavior of expert opinions regarding farmland values is beneficial to the general public because typical estimates of farmland values are typically based on expert opinion surveys.

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



Impact of COVID-19 across vulnerable and marginalized groups in the rural Iowa

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

This is a final report on this project. The COVID-19 global pandemic continues to be a major public health crisis in the rural Midwest and rural Iowa, severely impacting the health, economic, and emotional welfare of residents (Peters et al. 2021; Devlin & Kent 2021). Rural places are highly susceptible to COVID because of large senior populations, institutionalized residents, people with underlying medical conditions, and the presence of large meat processing facilities (Peters 2020). Rural communities also face socioeconomic challenges that limits their ability to respond to and recover from the pandemic. This includes closures of local hospitals and clinics, absence of mental health services, and fewer non-profit organizations. COVID has killed a larger share of rural people, with cumulative mortality rates being 44% higher in rural versus metro counties at 425 vs. 295 per 100k (JHU

2022; Dong et al. 2020). Missing from the academic and policy discussion is the pandemic's impact on smaller communities, even though mortality has been high. Missing from the discussion is how COVID has disproportionately impacted rural people of color. *There is an immediate need to understand the socioeconomic, health, and emotional impacts of COVID-19 in understudied rural communities, especially in meatpacking towns dominated by people of color.*

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 partnership with the Iowa League of Cities and the League of United Latin American Citizens of Iowa, we developed policy briefings and delivered community talks about the impact of COVID in Iowa's small towns and meat packing communities. Data and analyses came from the Iowa Small Towns Project, which surveyed nearly 13,000 households across 73 communities, including nine towns with large shares of persons of color (including three majority-minority packing towns). Results were used to document the financial, physical health, and mental health impact of COVID among persons of color, health compromised persons, elders, as well as among the white non-elder population. Results that COVID has a minimal impact on Iowa's rural seniors. For rural Whites, COVID was experienced as a mental health issue. For the health compromised, it was a threat to physical health. For rural persons of color in Iowa, COVID was a major financial and health emergency. Policy reports were published by ISU Extension and Iowa LULAC.

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

The Iowa Small Towns Project COVID-19 data wave was instrumental in helping stakeholders document the impact of the pandemic in order to prioritize programs and to advocate for additional resources. For example, the Iowa League of Cities and the Iowa Department of Health and Human Services was able to target mental health programming to specific subpopulation in specific regions of the state using the data. Further, IDHHS was also able to use the data to determine financial needs and program utilization in meat packing communities. LULAC used the policy briefs to advocate the state and federal governments for additional assistance to Latino population in Iowa, especially communities with large meat packing facilities.

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

By using the COVID-19 data for rural Iowa, state government is better prepared to understand how large scale pandemics impact certain subpopulations differently, allowing agencies to develop specific strategies and tailor programs to meet the needs or vulnerable groups. Further, the data and analysis documented a trust gap among certain subpopulations that needs to be addressed, as well as how best to communicate information about pandemics to specific subpopulations.



Research on minority and rural self-employment furthers understanding of barriers to starting and maintaining businesses

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

This is a final report on this project. Small businesses are critical to increasing the economic wealth of small towns. However, there are many barriers to starting businesses that adversely impact the ability for individuals to find success. Barriers to entrepreneurship are highest for disadvantaged populations, such as racial and ethnic minorities, immigrants, women, and rural folks. This research project, conducted by Dr. Sam Mindes, aims to improve our understanding of these impediments to business development through the analysis of secondary data from the American Community Survey and Current Population Survey, among other exceptional datasets. One emphasis of the project is on Hispanics, who are important contributors to the self-employment sector. Their entrepreneurial activity varies by immigration status and ethnonational subgroup. The project also investigates the impact of the COVID-19 pandemic on self-employment. The pandemic had a harsh impact on women, minorities, and self-employed individuals. Driven by sociological theory, the project uses regression models to identify key predictors of self-employment across disadvantaged groups. The findings further our understanding of how different populations engage in self-employment (including by rural/urban status, industry, region, etc.) and which individual characteristics increase odds of being self-employed (race, gender, children, homeownership, etc.). Analysis of data from the COVID-19 pandemic focuses on how inability to work due to the pandemic in the wage and self-employment sectors. Findings from the project inform program and policy development and efforts to support small businesses. These efforts improve rural economic development, rural wealth creation, and small-town sustainability.

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 project contributed to our understanding of the barriers to cultural and economic wealth in small towns through an investigation of the barriers to starting and developing businesses for vulnerable populations. In rural towns, small businesses are critical to sustainability of communities. Small town residents still constitute a substantial portion of the state population

and small towns are a significant part of the cultural and economic heritage of Iowa. Understanding, and ultimately reducing, barriers to starting businesses is critical for small Iowa towns to flourish. Those barriers tend to be most prominent among socially disadvantaged populations, such as immigrants, racial and ethnic minorities, women, and rural communities, among others. This project seeks to advance our understanding of the patterns and barriers in entrepreneurship for these groups, especially during the COVID-19 pandemic.

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

Results from this project have been disseminated in peer-reviewed journals. Additional press releases through ISU extension have dispersed these findings to audiences outside the academy. An interview with a rural community radio and podcast have increased the reach of the research to the public. The audience for this project has benefited from the project through increased knowledge which offers critical information for decision-making for policies and programs. The communication of this research in academic journals will have a lasting impact on our broader understanding of how this and future pandemics had unequal impacts across society and exacerbated existing inequities. Having a better understanding of the barriers disadvantaged groups face in entrepreneurship is critical to developing appropriate programs and policies that benefit all groups, including the most vulnerable during health crises and normal times. This project contributes to the growing body of knowledge by comparatively analyzing the inability to work due to the pandemic in the wage and self-employment sectors, using recent data to explore patterns of work interruptions across sectors and industries by many social categories, such as race, ethnicity, gender, family status, age, and education. The project also analyzes data on the entrepreneurial patterns among immigrants and Hispanic populations to improve our understanding of the unique barriers to self-employment faced by these groups. Information from the project also informs policymakers.

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

The project broadly contributes to the body of research on barriers to entrepreneurship for minorities, rural communities, and women, especially during the COVID-19 pandemic. These research activities deepen our understanding of the problems faced in vulnerable communities — increasing the knowledge on the issue. Findings aid in policymaking and program development by offering recommendations. These activities will better inform the public of the economic and social challenges faced during the pandemic.

Critical Issue

Food Production and Agricultural Systems

Capitalizing on the Synergy of Annual Forages to Manage Production Risk in the Cow-Calf Enterprise

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7004281



2022: Capitalizing on the Synergy of Annual Forages to Manage Production Risk in the Cow-Calf Enterprise

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

In a recent (2018) Iowa Beef Center evaluation of extension grazing programs, nearly 80% of the roughly 1,000 respondents surveyed indicated they incorporated cover crops (winter annuals) into their farming enterprise. Respondents also wanted more research on cropping systems incorporated with cattle production, including the long-term benefits of adding small grains into the rotation, double cropping cool-season forages with summer forages, and altering cropping rotations to incorporate grazing into the enterprise. Incorporating a summer annual into the crop rotation provides needed mid-summer forage grazing while taking limited row crop acres out of production. A winter annual/summer annual forage rotation disrupts the traditional corn/soybean rotation to reduce pest pressure, rotate pesticides, and scavenge soil nutrients; provides enterprise flexibility on the farm; and provides feed supplies during three critical seasons when perennial pasture production is insufficient. Midwest beef producers have been experimenting with this rotation but have indicated a desire for help analyzing the economic risks and rewards. This project included on-farm demonstrations/field days, research farm plots for yield and quality comparisons, presentations via traditional programs, and social media distribution.

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.

This program focused on the synergy of incorporating annual forages into the farming operation to manage production risk associated with weather extremes, diversify the cropping system, control cow grazing costs, and improve soil health. Utilizing winter annuals followed by a summer annual can provide additional forage for grazing.

Research measuring forage production and quality from a winter annual/summer annual forage rotation was conducted at the Northeast Research and Demonstration Farm and is reported in the research farm annual report and the ISU Animal Industry Report. On-farm demonstration field days were held at 15 locations and information was presented at 15 other meetings directly reaching 732 producers. An additional 8800 social media contacts were made through YouTube, Facebook, blogs, and podcasts. Target audiences for this program were ruminant livestock operators who graze forages (beef, dairy & sheep), land owners, and cash grain farmers.

Program Goals:

- Increase knowledge of winter and summer annuals in five key areas: annuals' environmental benefit, yield and nutritional differences, selection of annual species, economics for crop rotation, and economics for feed.
- Increase the use of winter and summer annual forages by Iowa cattle producers.
- Improve forage production and profitability of Iowa cattle producers' operations.

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

Iowa State University Extension and Outreach Beef Specialists and Field Agronomists collaborated to develop and deliver a multi-faceted extension program to reach cow-calf producers. On-farm demonstration field days were held at 15 locations across the state and information was presented at 15 other meetings directly reaching 732 producers. Cooperating programs included the Iowa Forage and Grassland Council, the Crop Advantage Series programs in two Iowa communities, the Cornbelt Cow-Calf Conference, the Driftless Region Beef Conference, the Winter Grazing Day, and the Eastern Iowa Hay Producers Association. An additional 8,800 indirect, social media contacts were made through YouTube, Facebook, blogs, and podcasts. Five Facebook posts regarding information captured as part of the project reached 7,111 people with 383 engagements. Six #CowTipTuesday videos were created related to annual forages and were viewed 1,345 times on YouTube since the start of the program. A podcast, "Weatherproof your grazing system", was also recorded with the Iowa Cattlemen's Association. It was released on April 22, 2022, and resulted in 1,052 downloads/listens.

These programs resulted in a total of five articles published in the following popular magazines: Hay & Forage Grower, Iowa Farmer Today, and Beef Magazine. Additionally, three articles were also published in the Iowa Beef Center Growing Beef monthly newsletter articles as well as the Integrated Crop Management (ICM) News blog. Two radio interviews on grazing winter annuals were also aired.

The addition of winter or summer annual forages into a grazing system has several advantages including reducing erosion, living forage over more of the growing season, breaking up continuous cropping systems, and providing rest for pastures. However, the biggest immediate advantage to cattle producers is the availability of forage grazing outside the traditional grazing period. Compared to purchased feeds, a week of additional grazing reduces the stored feed bill by \$15 per cow (35 lb hay per cow per day at \$120/ton).

A field day registration and evaluation card was distributed at eighteen field days or presentations with over 270 attendees to measure immediate knowledge change and intentional changes. A follow-up evaluation was mailed to 217 participants of the field days to measure longer-term knowledge change and practices adopted or used. Capitalizing on the synergy of annual forages to manage beef cattle production risk increased participants' knowledge of the environmental benefit of annuals, yield & nutritional differences, selection of annual species, economics for crop rotation, and economics for feed. Based on weighted averages, this project impacted 53,428 cows and 378,917 acres in Iowa. Of those who have adopted annual forages, the practice has added 68 days of grazing in the fall, 47 days in the spring, 52 days in the summer, and 65 days in the winter. Using the weighted average return of \$3.91/acre for 539 acres, resulting in a return of \$2,107 per participant or \$1,481,000 for all 703 project participants.

Corresponding Outcome Measure Statement(s): Immediately after participating in the annual forage on-farm demonstrations and events, 75% of participants will self-report an increase in five different knowledge indicators related to annuals' environmental benefits, yield and nutritional differences, selection of annual species, economics for crop rotation, and economics for feed.

- Using post-event evaluations, 88% of participants (107/121) reported an increase in knowledge in one or more of the five knowledge indicators.

Corresponding Outcome Measure Statement(s): Following program participation, 50% of participants will report making at least one change involving annual forages to their operation.

- In a follow-up evaluation, 60% of participants (35/58) reported making one or more changes to their operation involving annual forage production, and on average made three changes to their forage operation.

Corresponding Outcome Measure Statement(s): Following program participation, participants will report increased grazing days as a result of incorporating annual forages into their rotation and improved profitability of at least \$3.00 per acre.

- In a follow-up evaluation, 66 respondents who had experience with annual forages anticipated that annual forages can provide about 68 grazing days in the fall, 47 days in the spring, 52 days in the summer, or 64 days in the winter. The weighted average return per acre was \$3.91/acre for those who attended a program.

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

Utilizing winter annuals followed by a summer annual provides additional forage for grazing, reducing grazing costs, improving local economic conditions, and improving soil health, which leads to improved water quality and resiliency to extreme weather events.

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.

Hay & Forage Grower

- <https://hayandforage.com/article-4055-there%E2%80%99s-a-plethora-of-winter-grazing-options.html>
- <https://hayandforage.com/article-3794-cover-crops-offer-grazing-opportunities.html>
- <https://hayandforage.com/article-3772-swath-graze-cattle-to-save-and-gain.html>

Iowa Farmer Today

- https://www.agupdate.com/iowafarmertoday/news/livestock/cover-crop-adds-feed-benefit-soil-boost/article_934dcd0e-a49c-11ec-bd9d-278a77090b9a.html
- https://www.agupdate.com/iowafarmertoday/news/livestock/timing-critical-to-grazing-cover-crops/article_e0f23962-23b0-11ed-9952-7bf1c9778fd8.html

Beef Magazine

- <https://www.beefmagazine.com/grazing-systems/extend-fall-grazing-season-cover-crops>

NC1195: Enhancing nitrogen utilization in corn based cropping systems to increase yield, improve profitability and minimize environmental impacts

Project Director

Marshall McDaniel

Organization

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Accession Number

7000755



Carbon Sinks

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

The soil's ability to supply nitrogen to crops is controlled to a large extent by the size of the soil organic carbon (SOC) pool, so it is important to understand how SOC stocks are changing over time in agricultural systems. In particular, it is critical to understand the mechanisms by which climate change is affecting soil carbon stocks, so that farmers can respond and adapt their practices.

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 used resampling studies from Iowa and Illinois to determine changes in surface soil and subsoil in SOC stocks between the 1950s and early 2000s, compiling SOC concentration and bulk density data from two published observational studies with data dating back to the 1950s, and two experimental studies that were started in 1954 and 1979 in Iowa. Carbon input data were included in the analyses. We compiled data from weather stations concerning historical precipitation, vapor pressure deficit, and soil water content. We used statistical models to estimate changes in SOC stocks over time by specific depth layers, to analyze weather data, and soil water-filled pore space. This enabled us to compare the subsoil organic C stocks over time, and with the

US EPA estimates of US greenhouse gas emissions. These studies enabled us to identify that the subsoil in agroecosystems in Iowa and Illinois has become a carbon sink, a storage for carbon that is important to maintain if we are to reduce greenhouse gas emissions.

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

Our target audience of agronomists and farmers benefited because this study demonstrated that although surface soil SOC stocks have been declining over time, subsoil SOC stocks have been increasing. Our evidence indicates that the accumulation of organic C in subsoils is in part the result of regional climate change, which in this region has been accompanied by greater precipitation and wetter subsoil that reduce soil organic matter decomposition. Farmers may respond to this increasing soil wetness by expanding and intensifying their artificial drainage infrastructure. Our results indicate that this would increase the rate of subsoil SOC decomposition, thereby exacerbating greenhouse gas emissions in agriculture, and thus provide a rationale for avoiding the practice of increasing subsoil water drainage.

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

The broader public increasingly understands climate change issues and the need to reduce greenhouse gas emissions, but it can be unclear as to which particular practices could actually avoid carbon losses from agroecosystems. The results of this study link a broader public concern about climate change with a specific management practice, for which a solution could be devised.

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.

Poffenbarger H, Archontoulis S, Danalatos G, Dixon P, Russell A, Six J, Takle E, Veenstra J, Castellano M. A large subsoil carbon sink in the United States Corn Belt. Submitted to Global Change Biology.

Practical Management of Nematodes on Corn, Soybeans and Other Crops of Regional Importance

Project Director

Gregory Tylka

Organization

Iowa State University

Accession Number

7000555



Iowa State University field research results help Iowa farmers select SCN-resistant soybean varieties and nematode-protectant seed treatments

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

The soybean cyst nematode (SCN) is the most damaging pathogen of soybeans in Iowa, the United States, and North America. It is estimated to have caused \$1.5 billion in yield loss annually from 1996 through 2016. A primary way to manage this soil-borne, parasitic worm is by growing SCN-resistant soybean varieties. There are hundreds of different SCN-resistant soybean varieties from which farmers can choose, and the yield and SCN control provided by the varieties can vary greatly. Also, nematode-protectant seed treatments have become available for farmers to use on soybeans. There are at least 10 nematode-protectant seed treatments for soybeans from which to choose, and the benefits provided by the varieties and the seed treatments also can vary significantly. The objectives of this project were: 1) to compile information on the choices of resistant varieties and the seed treatments available to soybean farmers to aid in their decision making, and 2) to provide data from experiments conducted in Iowa fields on the benefits (increased yields and/or decreased reproduction of the nematode) of the resistant varieties and seed treatments.

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 list of SCN-resistant soybean varieties available to Iowa growers was compiled in October 2021. The list was created as an Iowa State University Extension publication that was made available free of charge on the Internet in PDF format. The 2021 list contained information on 872 resistant soybean varieties in maturity groups 0, 1, 2, and 3.

Also, hundreds of soybean varieties described as resistant to SCN were evaluated in nine field experiments in Iowa to assess the agronomic performance of the varieties and their suppression of population densities of SCN. There were three experiments conducted in SCN-infested fields across northern Iowa, three across central Iowa, and three across southern Iowa in 2021. Individual plots in each experiment were four rows wide, each 17 feet long, and data were collected from the center two rows. Each variety was replicated in four blocks in each experiment. The data collected included SCN egg population densities (numbers) at planting and at harvest and grain yield. Nine very similar experiments were established again in 2022.

Field experiments also were conducted in 2021 to study the effects of three nematode-protectant seed treatments on soybean yields and SCN soil population densities throughout Iowa. The experiments were located in the same fields in which the variety evaluation experiments described above were conducted in 2021. There were nine experiments comparing three different nematode-protectant seed treatments on top of their base insecticide and fungicide seed treatment to just the base alone. Each experiment had 12 replicate plots of the two paired seed treatments (nematode-protectant seed treatment plus base vs base alone). All plots were 17 feet long and four rows wide. As with the experiments with resistant soybean varieties, SCN population densities were determined from soil samples collected from the center two rows of each plot at planting and at harvest, and yields were collected from the center two rows of each plot as well. Also, experiments very similar to what were conducted with nematode-protectant seed treatments in 2021 were established in 2022 as well.

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

There are two primary target audiences for the work of the project: 1) soybean farmers and 2) agribusiness personnel who advise soybean farmers. The results of the project allow these individuals to better manage the soybean cyst nematode for higher yields in both the short term and long term by selecting the most effective SCN-resistant soybean varieties and nematode-protectant seed treatments for use in fields infested with the soybean cyst nematode. Also, all of the information produced in this project will be useful to soybean farmers and those who advise them in soybean-producing states east and west of Iowa.

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

The impact of the variety evaluation experiments was estimated by an Iowa State University distinguished professor of agricultural economics to be worth \$200 million between 2011 and 2016, which is \$33.3 million each year. See <https://crops.extension.iastate.edu/cropnews/2022/02/scn-resistant-variety-trial-information-estimated-have-provided-over-200-million> for more specific information.

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.

<https://doi.org/10.1094/PDIS-12-20-2581-RE>

<https://doi.org/10.37578/ONKA5947>

<https://doi.org/10.37578/UDSP9793>

Sustainable and Profitable Management of Corn Rootworm in Iowa

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7004282



2022 Sustainable and Profitable Management of Corn Rootworm in Iowa

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

Corn production in Iowa is valued at \$9.87 billion. One insect pest that potentially impacts the profitability of every farm in Iowa is the western corn rootworm. In particular, western corn rootworm resistance to all commercially available Bt hybrids poses a significant threat to sustainable and profitable corn production. A recent needs assessment determined a lack of client knowledge on identification, scouting, and best management practices for corn rootworm. It is critical to educate farmers on corn rootworm biology and research-based crop protection strategies, in addition to providing recommendations for long term, profitable decision making. There will be novel suppression strategies commercially available in 2022 and preservation of this tool is essential for return on investment.

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 increased concern for corn rootworm combined with a demonstrated need for education prompted twelve ISU Extension and Outreach agronomists and entomologists to organize hands-on demonstrations across Iowa in 2022. These field days were held at seven ISU Research and Demonstration Farms in June, July, and August. There were three learning objectives for the field days: improve the identification of two corn rootworm species, increase confidence in recognizing and rating larval root injury, and understand effective management options for corn rootworm. Each research farm planted a demonstration showing a range of management tactics, from the “do nothing” approach (no Bt traits or insecticide) to the “kitchen sink” approach (Bt + RNAi + soil-applied insecticide). Participants were able to compare different management tactics, learn about the “float test,” observe a spectrum of root injury, and practice using the 0-3 node injury scoring system. Attendees also got to interact directly with extension personnel to answer questions in small groups. This hands-on approach allowed participants to observe and learn detailed methods for sampling corn rootworm and evaluating management tactics that are difficult to convey in a lecture setting. A 6-page handout and a small scouting card were provided to each participant.

The overarching participant learning objectives of this educational program are to:

1. increase accurate species identification and biology of corn rootworm;
2. improve scouting efforts, estimate plant injury, and predict yield loss;
3. detect when unexpected injury (resistance) is occurring;
4. understand available options for effective management; and
5. implement a rotational strategy to further delay Bt resistance problems in Iowa.

Farmers will benefit from this program in two ways: 1) directly training farmers will increase their confidence in identifying issues and making appropriate management decisions, and 2) training agricultural professionals (industry agronomists, crop consultants, etc.) will improve their understanding and ultimately improve our reach to farmers. Ultimately, farmers will receive a research-based educational program from a trustworthy and knowledgeable source.

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

Participants completed a post-pre survey that assessed participants’ knowledge before and after the event for the demonstration learning objectives. Farming audiences were also asked whether they planned to make any management changes with the knowledge gained from the event and to estimate the increase in profits from that knowledge.

Survey responses indicated an increase in confidence in identifying northern and western corn rootworm adults following the demonstrations. The number of people self-reporting high confidence increased from 36 to 82% following the event. There were also significant improvements in confidence in recognizing and rating root injury from corn rootworm larvae. Following the event, 49% of people self-reported high confidence compared to 13% prior to the event. Participants gained a better understanding of the complexity of effective corn rootworm management. The number of people reporting a high level of concern for effective management with Bt was raised from 38 to 60% following the demonstrations.

Of the 29 respondents that indicated they were farmers, 55% planned to make management changes next year with the information they learned from the demonstration. Approximately 31% of farmers said they were not sure whether any management changes would be made. Nearly half (48%) of farmers expected to see a \$5-10/acre increase in profits with the information gained from the demonstration. These farmers reported growing 3,788 acres of corn combined in 2022. 21% of farmers expected between \$11-20/acre more in profit following the demonstration (1,180 corn acres in 2022), and 10% expected an increase of more than \$20/acre (1,150 corn acres in 2022).

Corresponding Outcome Measure Statement(s): Immediately after completing each educational event, 75% of participants will self-report their ability to accurately identify corn rootworm species.

- Immediately after completing each educational event, 82% of participants self-reported an increase in their ability to accurately identify corn rootworm species.

Corresponding Outcome Measure Statement(s): Upon conclusion of field events, 50% of participants will be able to:

1) effectively scout for corn rootworm larval activity;

2) accurately estimate plant injury; and

3) confidently predict yield loss.

- Following the event, 49% of people self-reported high confidence in recognizing and rating root injury from corn rootworm larvae.

Corresponding Outcome Measure Statement(s): Upon the conclusion of field events, 30% of participants will modify existing management strategies to delay Bt resistance in the field.

- 55% of participants self-reported they planned to modify existing management strategies to delay Bt resistance in the field with the information they learned.

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

The statewide corn rootworm demonstrations during the summer of 2022 provided farmers, crop consultants, and industry professionals the chance to observe management tactics, assess root injury, and increase knowledge of identification and sampling for corn rootworm. Most of the farmers that attended the events plan to use their new knowledge to make management changes for corn rootworm, and nearly 80% of farmers (23/29) that responded to the survey expect to increase their profits by at least \$5/acre on their combined 6,118 acres. The corn rootworm demonstrations improved the confidence of participants in diagnosing corn rootworm issues in the field and knowledge of corn rootworm management tactics, which prepares them to make sustainable and profitable management decisions in the future. Profitable farms lead to stronger local economies, and improved stewardship of corn rootworm management tools reduces impacts on the environment in the long term.

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.

Dean, Hodgson, Rieck-Hinz, and Anderson. 2021. Needs assessment of corn insect pest management in Iowa. Journal of Integrated Pest Management. <https://academic.oup.com/jipm/article/12/1/27/6319925>

Nutrient management to improve the profitability and sustainability of cropping systems and minimize phosphorus impacts on water quality.

Project Director

Antonio Mallarino

Organization

Iowa State University

Accession Number

1024779



Nutrient management to improve the profitability and sustainability of cropping systems and minimize phosphorus impacts on water quality

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

This project's goals are to improve the sustainability and profitability of crop production systems of Iowa and the northcentral region and minimize water quality impairment. Projects and outreach for four main objectives address assessments of the crop availability of soil P and K by soil testing, processes underlying several P and conservation management practices that impact the amounts of dissolved and particulate P loss with surface runoff, and effectiveness of commonly used and new liming materials to control soil acidity in corn-soybean rotations.

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.

Completed data management for field trials conducted in 2019 and 2020 to better understand relationships between soil-test P and the corn and soybean yield response for contrasting Iowa soils. Previous P treatments at each of five locations until 2018 had created wide soil-test P ranges across 240 plots and one nonlimiting P rate was applied to assure maximum yield estimates. Soil P was measured by the Bray-1, Olsen, and Mehlich-3 with both colorimetric and inductively-coupled plasma determination of extracted P (ICP). Relationships between relative grain yield responses and soil-test results showed no relevant differences among the soils Kenyon (Typic Hapludoll), Webster (Typic Endoaquoll), Galva (Typic Hapludoll), Mahaska (Aquertic Argiudoll), and Marshall (Typic Hapludoll). However, results indicated a need to slightly increase upwards the boundaries of the soil-test interpretation categories existing since 2013. An updated version of the ISU extension publication PM 1688 with new guidelines will be published in January 2023, and a journal article is in preparation.

Objective 2.

A. Completed the final project report to the Iowa Nutrient Research Center for a six-year study in small watersheds (0.5 to 1 ha) to assess the value of no-till and a cereal rye cover crop over-seeded before crop harvest to remediate N and P loss with runoff from corn-soybean fields testing high in P. Results were summarized in last year's report, and showed no-till and a cover crop reduced crop yield but greatly reduced runoff, soil, DRP, total P, dissolved N, and total N losses, although the cover crop was much more useful with tillage than with no-till. A journal article is in preparation.

B. Completed the final project report to the Iowa Nutrient Research Center for a 3-year study at one site using 0.2-ha plots for no-till corn-soybean rotations under natural rainfall maintaining optimum to high soil-test P to assess impacts of P placement and rate/timing of application and a cereal rye cover crop on P loss with runoff. Six systems with each crop present each year in adjacent plots were annual broadcast P in the fall (1) or spring (2), annual planter-band P in the spring (3) twice the annual P rate broadcast in the fall only before corn (4) or soybean (5), and (6) cereal-rye cover crop every year and twice the annual P rate broadcast in the fall only before corn. Spring broadcast or subsurface P banding in the spring of the annual maintenance P rate reduced dissolved and total P losses compared with similar or larger P rates broadcast in the fall. However, this result was partially explained by runoff occurring mostly in March of every year when the fall broadcast applications had been done but before the P applications in the spring. In Iowa, most often surface runoff occurs between April and late June, when high-intensity rainfall and runoff are more common. A journal article is in preparation.

Objective 3.

A. A study initiated early in the previous period has investigated soil K dynamics with field, soil incubation, laboratory, and mineralogy (X-ray) work. Previous reports summarized results from field trials concerning soil series and chemical properties effects on temporal variation of soil K pools (soil-test K measured using dried or field-moist samples and nonexchangeable K) and relationships between soil-test K and the corn or soybean yield response to K fertilization. Data management and summarization continues by studying impacts of soil clay mineralogy on soil K pools and crop yield responses and on results of soil incubation work. The incubation included with 23 soils from Iowa and five neighboring states to study soil properties and K application impacts on soil K pools for two moisture regimes. There was less progress than planned due to complications from COVID-19 for the Ph.D. student. However, data management and writing for three chapters of the student Dissertation is progressing well, and will be completed for his graduation in May 2023.

B. Completed a study to assess the value of in-season fluid K fertilization as a complement to preplant fertilization for corn and soybean using 12 two-year trials in Iowa soils. All trials began with corn (six trials in 2018, six in 2019). Ten initial treatments were five preplant K rates (0-126 kg K/ha) with broadcast granulated fertilizer, each sidedressed with 0 or 42 kg K/ha of injected fluid potassium-acetate between corn rows at the V6 growth stage. Soybean was planted in the second year, for which only the fluid K treatments were reapplied. A preplant rate of 42 kg K/ha increased corn yield and ear-leaf K more than a similar rate of sidedressed fluid K fertilizer. Sidedressed K sometimes increased corn yield further with an 84-kg preplant rate but seldom did for the highest rates, increased soybean yield only with corn preplant rates of 0 or 42 kg K/ha because of large residual effect with higher rates. Therefore, sidedressing K is a good rescue option with insufficient preplant K but producers should not reduce preplant rates to be complemented by K sidedressing.

Objective 4.

A. Completed a study to evaluate impacts of calcitic aglime, pelleted lime, and finely ground calcium carbonate on soil pH and corn-soybean rotations grain yield. Results from six two-year trials using various rates applied before corn showed that a pelleted lime being sold in the northcentral region has much higher effective calcium carbonate equivalent (ECCE) concentration than aglime sources despite the granulation. This was confirmed by field trials, which showed similar rates and time to maximize soil pH and to attain maximum yield to calcium carbonate and better than aglime. The results differ from those of older research using a different product, which may be explained by finely ground calcitic limestone used for the pelleted lime. Pelleted lime is more expensive than aglime, so despite likely better distribution producers should select the lime source according to the cost by unit of ECCE.

B. Completed data management and summarization for a final report to the funding agency and outreach of a follow-up study 2-year study at six sites to assess strategies for pelleted lime use. Results for the first crop (corn, in 2020) were summarized in the last report. First-year treatments were a control and six pelleted lime rates (112-7200 kg/ha) broadcast and incorporated into the soil. Corn grain yield responded curvilinearly with increasing increments to a maximum with the highest rate, which on average across sites increased yield by 1.0 Mg/ha but yield for the second-high 1800-kg rate was only 149 kg/ha lower. Rates of 112 and 224 kg/ha did not increase soil pH but resulted in very small yield increases whereas the 1800-kg rate increased pH to 6.0 and the highest rate increased pH to 6.5 or higher (optimum pH for corn and soybean in Iowa is 6.0 or 6.5 for different soil associations). After corn harvest and soil sampling in fall 2020, limed plots were subdivided into two halves to study residual effects of initial rates and reapplied similar rates on the second-year soybean (2021). The initial rates applied before corn increased soybean grain yield curvilinearly to a maximum attained with the highest initial rate of 0.75 Mg/ha on average across sites but yield for the

second-high rate was only 66 kg/lower. Soybean yield for the reapplied (annual) rates was significantly higher than for residual effects of the initial applications except for the highest rate. Relative yield increases across both crops to initial single rates were 1.9, 2.5, 3.9, 6.2, 7.5, and 9.0% whereas for the annual rates were 2.8, 3.5, 4.5, 7.2, 8.8, and 9.1%. Overall, application of single or annual pelleted lime rates lower than needed to increase soil pH to 6.0 or 6.5 limited crop yield significantly at most sites.

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

The research results from the studies described in the previous section the four project objectives (improving efficiency of phosphorus, potassium, and pH-lime management and minimizing losses of phosphorus loss with surface runoff to improve water quality) and potential impacts were shared and discussed during the 2022 calendar year during 55 conferences or field days and by nine published articles or abstracts. The target audiences of these activities included farmers, crop consultants, nutrient management planners, researchers, university extension agronomists or soil/water resources specialists, researchers, and/or technical personnel of federal or state government agencies with outreach or regulations responsibilities related to soil or water conservation.

The presentations were at 49 Iowa extension conferences, field days, or state nutrient management certification programs; four regional extension conferences, two conferences to international visitors, and two research talks at the 2022 meeting of the ASA-CSSA-SSSA societies. None of these were included in the previous progress report.

The information summarized for publication included five extension articles and two final grants project reports that were posted at extension websites (<https://crops.extension.iastate.edu/cropnews> or <https://www.agronext.iastate.edu/soilfertility/homepage.html>) and two research abstracts/posters that were posted at the website of the 2022 Annual Meetings of the ASA, CSSA, SSSA societies (<https://scisoc.confex.com/scisoc/2022am/meetingapp.cgi/Paper/146379> and [/paper 146361](https://scisoc.confex.com/scisoc/2022am/meetingapp.cgi/Paper/146361)).

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

The general public and the society benefited by provided improved or new knowledge about nutrient management practices that should result in improved efficiency and amount of feed and food production, economy of the agricultural sector, conservation of soil and nonrenewable plant nutrients, and water quality in Iowa freshwater resources and the Gulf of Mexico.

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 opportunities for training and professional development of two graduate students and a research scientist. Also, the project has helped me and Iowa State University by significantly expanding my research and extension program.

Enhancing Poultry Production Systems through Emerging Technologies and Husbandry Practices

Project Director

Richard Gates

Organization

Iowa State University

Accession Number

1020933



Commissioning poultry research facilities as part of the design/build process

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

This collaborative multistate research encompasses a multi-disciplinary approach to create resilient poultry production systems through optimal management of inputs and outputs in an ethically responsible manner. Developing and maintaining resilient poultry systems requires continuous improvement of our knowledge base in numerous areas, including (but not limited to) engineering, poultry science, veterinary medicine, and animal welfare.

Specifically, we have 2 objectives:

1. Develop and test a methodology for systematically implementing a commissioning project for two new poultry research facilities. The methodology must include detailed documentation of specific measurements, and the results of these measurements. If problems are encountered with the facility because of the initial commissioning, the methodology must incorporate a means of documentation and re-assessment.
2. Assess the opportunity that a detailed commissioning report provides for use in building energy monitoring, building zone control of biosecurity, documentation of baseline performance for future comparison, and the provision of a critical review of animal environment conditions for purposes of animal welfare certification and assessment.

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 design, construction, and startup of research facilities used for animals of agricultural importance is an expensive and time-consuming process. Once the facility is finished, the critical startup phase will begin and this phase historically is fraught with challenges that relate to errors in construction, from flawed design thinking and project oversight, and others from miscommunication between research personnel, project managers, and administrators. This is surprisingly normal, yet avoidable, by implementing a "building commissioning" methodology directly into the design phase of these research facilities.

In this project, we have now developed the methodology for commissioning and deployed it on our new turkey research complex at Iowa State University. The methodology was developed in concert with move-in and startup of a more complex laying hen teaching and research facility that did not have commissioning as part of its design phase. The methodology has been used on the brood section of the turkey facility and is being actively managed as the grow/finish sections are completed during spring 2023.

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

This multistate's project collaborators include academics from 23 institutions, most of which at some time upgrade or design/build new research facilities. By communicating our efforts and findings at Iowa State University to our colleagues, this knowledge transfer will also enable other land grant universities to deploy commissioning as part of their design/build process and streamline the startup of new or remodeled facilities for teaching and research in poultry and other intensive livestock production.

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

Commissioning is a relatively low-cost addition to a facility design process, with payback that includes more efficient transfer from construction to use, better understanding by key staff on how unit processes within a facility are supposed to work, and a rapid finding of problems before ownership is turned over from the contractor to the University. This saves taxpayer dollars and improves our ability to conduct high quality research unimpeded by facility constraints that could have been avoided.

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.

Three different semesters of student capstone design teams, two for Agricultural Systems Management and one for Agricultural and Biosystems Engineering, were engaged in developing standard operating procedures (SOPs) for the laying hen teaching and research facility. These SOPs form a part of the basis for the methodology deployed during the design and construction of the new turkey research facility, and are in development during the coming year. Substantial commissioning has been performed on the computerized environmental control system and associated ventilation system components. A unique, one-of-a-kind individual meal weighing system for feed delivery (with two lines and up to four feed combinations per line) to the grow finish pens (64 in total) is being installed and will be commissioned also. Each pen in both brooding and grow/finish also has 4 different water lines for water-based delivery of medications or other products, including dose-response investigations, and this will be commissioned in the coming year.

Development and utilization of genomic and phenomic approaches to efficiently exploit genetic variation for crop improvement

Project Director

Thomas Lubberstedt

Organization

**Increasing the efficiency of breeding climate resilient crops****In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

This umbrella project will develop and implement novel approaches to increase the efficiency of the plant breeding process with primary focus on the major crop species maize, soybean, and sorghum, transferable to other species. Importantly, most, if not all, co-PDs work closely with ISU colleagues in different engineering departments to accomplish their goals. ISU is actively promoting to transform Plant Breeding into an engineering discipline.

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.

Broadening genetic variation

- Suza lab: There is a growing interest globally in research to mitigate the impact of climate change on crop plants. Sterols such as stigmasterol might play a role in plant stress responses and reducing cholesterol in seed oil might have health benefits. In the longer term, research findings will be applied to improve the stress tolerance and nutritional quality of a crop of global interest.
- The Wang lab developed an improved protocol for genetically transforming maize inbred B104. B104 is an inbred that shares a high degree of genetic similarity with B73, an inbred of the reference genome and parent of many breeding populations. The advanced protocol requires only 7-10 weeks to generate transgenic plants compared to 16-22 weeks needed when using the previously developed protocols. The Wang lab also established a CRISPR RNA-guided integrase system for *Agrobacterium tumefaciens* genome engineering. *Agrobacterium* is a soil bacterium that has been widely used to genetically transform many plant species. The CRISPR integrase system enables the generation of new strains for enhanced plant transformation ability.
- Schnable lab: We obtained and phenotyped mutants of genes for which there is evidence suggesting that they regulate leaf architecture, an important trait for plants' adaptation to high planting density. We are similarly characterizing mutants of genes that have been shown to be important for maize adaptation and selection. These were phenotyped to monitor their end-of-season root architecture. Our preliminary results indicate many of these mutants exhibit alterations in both above and underground traits.
- A.K. Singh participated in a study of soybean sudden death syndrome that included image-based phenotyping of disease symptoms. This work used deep learning to develop a reliable and accurate method to phenotype disease incidence and severity to study disease resistance in plants and subsequently develop improved cultivars. The results of this used deep learning to capture complex phenotypic traits of disease symptoms (from images) to get comparable or more insightful results relative to the commonly used subjective visual ratings.
- Arti Singh lab – Mung bean breeding program is geared towards breeding mung bean varieties suitable for Iowa using the modified bulk method. Progeny row testing for superior single plant selections completed. Yield testing of advanced breeding lines at multi-locations in Texas, Wisconsin, and Iowa was conducted in the summer of 2022. Advanced multi-location trial is planned for next year with variety release planned in 2024. The diversity panel has been extensively evaluated for various agronomic traits and root system architecture traits. Abundant GBS markers (26,559) were generated to genotype the IMBD GWAS panel. FERONIA, a known flowering-pathway gene, was identified as the candidate gene for the quantitative trait locus (QTL) with the largest effect on days to flowering. A subset (375 accessions) of the IMBD GWAS panel was studied to dissect the root phenotypic and genotypic variability and potential genotypes in the topsoil foraging and with steep, cheap, and deep roots were identified as iRoot ideotypes. Breeding for field peas started by a screening of Plant material from the Germplasm Resources Information Network (GRIN) with field screening of 500 accessions (2021) and 340 accessions (2022), includes 3 released varieties as checks in single-row plot design in single replication yield trial, 14 accessions selected from the 2021 panels. Several Ground measurements were taken in 2021 for flowering note (date to flowering, flowering color), maturity, and seed characteristics (seed color, 100 seed weight), and yield was collected for the 500 accessions' panel. In 2022, flowering notes, canopy height, canopy temperature, and lodging height index were collected, and seed characteristics will be ongoing collected. In 2022 yield-testing, stem count, lodged canopy height, and plant length were collected, and yield was collected.

Maximizing genetic gain

- Climate change increases the urgency of understanding phenotypic plasticity. As climate change causes more volatile swings in weather, farmers and plant breeders will require better tools for predicting how crop varieties will perform under different environmental conditions. In a recently completed project, Yu's group demonstrated how the temperature swing between day and night affected sorghum plant height growth. With data collected for a sorghum population across

growing seasons in Iowa, Kansas, and Puerto Rico over the span of multiple years, we found that the temperature difference between daytime highs and nighttime lows affected the growth of sorghum plants significantly. By incorporating the weather information and DNA fingerprinting data, we developed an integrated analytical model to predict the final plant height of different sorghum plants and validated the effect of temperature on growth trajectories with empirical testings.

- Lawrence-Dill lab: Using natural language processing of phenotypic descriptions coupled with similarity network representation, we have a proof of concept that elements known to be associated with plant height in maize can be recovered. We have used similar methods also to demonstrate that gene functions can be used to infer biological associations.
- The Lubberstedt lab identified 2 genes in *Arabidopsis thaliana*, which, when mutated, increase haploid male fertility. Research is ongoing to validate respective genes in crop species. These findings may lead to doubled haploid (DH) technology, which no longer has to rely on toxic colchicine for DH line development.
- The Beavis lab demonstrated, using a previously developed selection algorithm, the Predicted Cross Value (PCV), that the traditional method for maize breeding (back-crossing only) may not be the most optimal method for introgressing alleles of interest. This selection algorithm can be used to select parents that will lead to the desired outcomes faster than traditional breeding methods. A manuscript has been written for single-allele introgression in maize using the PCV and is currently under internal review. The Beavis lab has preliminarily shown that the PCV can be adapted for a dioecious species.
- Schnable lab: Previously, we conducted three cycles of recurrent selection for early flowering in a population generated by intermating early flowering stocks. After the three cycles of selection, the selected population was shown to flower (days to anthesis, DTA) 4 days (8%) earlier than the base population. We are currently analyzing the genomic changes associated with this response to selection.
- The A.K. Singh group used Soybean Nodule Acquisition Pipeline (SNAP), which was co-developed with engineering colleagues at Iowa State University, to quantify nodules on soybean roots and evaluate for genetic diversity and growth patterns across unique soybean root system architectures. Nodules are important legume root structures where atmospheric nitrogen is fixed into bio-available ammonia for plant growth and development. We found unique growth patterns in the nodules of taproots – nodule count, size, and total nodule area – and observed that different soybean accessions varied amongst each other. Due to the improved phenotyping through SNAP, we were able to show (and quantify) nodulation as a function of nodule count and individual nodule area. This gives breeders the ability to estimate total nodule area per root or growth regions of the root. We also reported that taproot nodules and final seed nitrogen at maturity are correlated. Our research will help explore genetic variation and relationships leading to the utilization of this information for greater nitrogen use efficiency and nodulation carbon to nitrogen production efficiency across the soybean germplasm.

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

Various novel research methods and tools have been published in high-level publications (see a selection in "Comments" below) or reported in scientific talks by this group of investigators, which will benefit scientists in public or private entities to increase the efficiency of breeding or genetic studies for their crops and traits of interest. By introducing novel methods, tools, outcomes (such as isolated genes) and germplasm developed and published by this group, breeding efforts in various species will benefit and longer term results in better varieties for farmers developed at increased annual genetic gains.

Finally, this group was involved in organizing the 2022 National Association of Plant Breeders meeting at ISU, which allowed us to showcase our research to at least part of the target audience. The women in Ag and AI (WIAA) group participated in NAPB meeting field tours to showcase their plant breeding research involving AI-based plant phenotyping tools and techniques being used in crops like soybean, mung bean, and field peas. They also showed the beta version of insect pest scouting app to visitors during the field tours.

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

This group of investigators is engaging in interdisciplinary efforts with statisticians, engineers, bioinformaticists, and molecular biologists, among others. In this way, cutting-edge approaches are developed or implemented in our research efforts towards our overall goal, to develop and implement novel approaches to increase the efficiency of the plant breeding process with primary focus on the major crop species maize, soybean, and sorghum, transferable to other species. More efficient breeding processes will benefit a broader public by being able to provide improved germplasm in major crop species in shorter time, including efficient use of genetic resources. This is important in light of a changing climate, which requires adaptation to environmental challenges, novel pathogens, etc, and will both enable food security, but also development of varieties for novel breeding targets (eg, in relation to novel meat-free diets, or for biorenewable applications) in shorter time. Improved varieties are also key for a more sustainable agriculture using less N fertilizer (for example), thus resulting in healthier environments.

Another important tangible outcome is the multiple undergraduate and graduate students as well as postdoctoral scientists involved in projects of the project investigators. The majority move on to qualified positions in public or private entities as important contributions to enhancing the workforce in this disciplinary area (ISU is one of the top "producers" for graduate students in plant breeding in the U.S.). Field tours and presentations made by students staff and faculty during the meeting also helped in disseminating the research project's results and in broadening participation and future workforce development efforts.

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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doi: 10.3389/fpls.2021.808001
<https://doi.org/10.1093/jipm/pmab044>

Predicting Genotype by Management by Environment Interactions across Scales

Project Director

Sotirios Archontoulis

Organization

Iowa State University

Accession Number

1020989



Filling gaps in agronomic research to enable model predictions

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

Crop simulation models require several input parameters to operate and independent datasets to verify their performance. In this fiscal year, we performed research to collect-analyze such datasets. Two examples include data for maize leaf appearance rate and N leaching across regions 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.

We gained a better understanding of how fast maize develops across the US Corn Belt. This is extremely important as we develop/improve predictive models for future climate scenarios. Similarly, we gained a better understanding of how the weather affects the amount of nitrogen leached from Iowa croplands, which is important as we try to evaluate the impact of different management practices on N loss reduction. During the second project year, the project team performed over 50 field experiments from which we collected various phenotypes such as grain yields, and published over 15 peer-review manuscripts (see comments section). All this help achieve our project goal which is to enable the prediction of genotype by management by environment interactions at scale.

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

Our target audience includes various stakeholders: farmers, scientists, industry, students, policymakers. Our research provides actionable data to assist decision-making and to inform policy. In addition to research publications (see comments section), we have developed and maintained online tools for stakeholders to easily access the information generated through this project (see ISU Extension FACTS website and ISOFAST – see comments section).

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 policymakers 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.

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Web tools

FACTS: <https://crops.extension.iastate.edu/facts/>

Marketing and Delivery of Quality Grains and BioProcess Coproducts

Project Director

Gretchen Mosher

Organization

Iowa State University

Accession Number

1017235



Establishment and Utilization of the new ISU Feed Mill and Grain Science Complex

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

The new ISU Kent Feed Mill and Grain Science Complex is a unique state-of-the-art facility that is nearing completion. The facility will be operational by mid-2023 and it is expected that credit and non-credit courses will be offered as the facility opens. Technical and equipment capabilities of the facility were summarized in the 2021 report.

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 new facility was utilized for the in-person, on-site offering of the Advanced Grain Elevator Operations Management short course in August 2022 and the 3-credit Feed Processing and Technology course (TSM455/555) required for completion of the ISU Feed Technology Minor during the fall 2022 semester and the 3-credit Feed Safety, Ingredient Quality, and Analytics course (TSM 457/557) was taught in the spring of 2022. Over 500 people have visited the facility as part of 40 tours in 2022. Substantial progress has been made in developing the feed safety, quality management, personnel safety, and business management plans, and Standard Operating Procedures in preparation for operationalizing the facility.

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

Continuing education and training for the grain handling and processing workforce remains a challenge. In the grain industry, retirements average 8-12% each year, and there is concern about a succession in leadership, given the very low rate of qualified professionals with advanced degrees in grain handling and processing from U.S. land-grant institutions. Yet, the need for such professionals remains strong, as does their need for continuing education and advanced training. The ISU Feed Mill and Grain Science Complex is well positioned to provide some of the needed training and outreach, which will provide professional development and growth to rural professionals who work within the grain and feed handling system.

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

Iowa's grain and feed cooperatives operate in 618 Iowa locations, enrolling over 129,000 members, employing nearly 6,500 employees, and paying over \$26.7 million in property taxes. These data likely underestimate the economic inputs from the grain and feed industry in Iowa, as they focus only on cooperative locations. To provide professional development and advanced technical training will not only prepare Iowa and Midwest grain and feed professionals for job-related responsibilities, but keeping highly trained and educated people in rural Midwest communities improves the quality of life and vitality in these rural communities as well.

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.

No major changes or problems encountered in the approach.

Publication:

Rosentrater, K. A. 2022. Storage of Cereal Grains and Their Products, 5th Ed. Duxford, UK, 726 pp.

Critical Issue

Health, Nutrition and Well-being

The Role of Food Insecurity in the Association between Economic Hardship, Distress, and Health across the Lifespan

Project Director

Tricia Neppl

Organization

Iowa State University

Accession Number

7000987



The association between economic adversity, emotional distress, negative family processes, and health outcomes over time

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

The long-term goal of the proposed research project is to decrease economic hardship, family stress processes, food insecurity, and negative health outcomes. To help accomplish this goal, we focus on rural Iowa families; the findings could broadly impact the 46 million people living in rural areas in the U.S. Our work is crucial as rural communities may be particularly vulnerable to economic consequences, as they tend to have higher levels of poverty and fewer job opportunities. Relating more to public health, rural communities lack access to healthcare, have a heightened reliance on telehealth, and tend to have older and health-compromised individuals. Finally, living in a rural community places this population at risk for poor outcomes such as lower cognitive functioning, more substance use problems, and higher obesity rates than in urban areas. Additionally, food insecurity rates are higher in rural communities than in urban areas. According to the USDA report, 11% of rural households were food insecure in 2021. Therefore, food insecurity can be the major risk factor for rural individuals and families, exacerbating the association of multiple family variables and health outcomes over time, particularly for individuals from middle to older adulthood.

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.

For this reporting period, our two main goals were:

Objective 1: To examine the association between economic hardship, emotional distress, negative family processes, and health outcomes across the lifespan; and

Objective 2: To examine if family factors such as food insecurity exacerbate the association between economic hardship, emotional distress, negative family processes, and health outcomes over time, particularly among rural individuals and families.

To achieve the goals of the project, we utilize data from the Family Transitions Project, a 3-generation study of rural Iowa families that began in 1989 at Iowa State University. The data helps us understand the influence of economic adversity on individual and family health outcomes. The Family Stress Model (FSM, Conger & Conger, 2004) guided our research to examine how economic adversity is associated with emotional distress and negative family processes, which affects individual health outcomes. Thus, we examined how FSM pathways influence health indicators, including cognitive function, obesity, and emotional distress across adolescence and adulthood. In this section, we discuss several conference presentation studies that we conducted during the current reporting period.

For the first conference presentation, we examine how FSM pathways influence cognitive well-being in later adulthood, as assessed with the Modified Telephone Interview for Cognitive Status. Preliminary findings were consistent with the FSM, showing that a) economic hardship was related to economic pressure in early middle adulthood, b) economic pressure was related to females' emotional distress in middle adulthood, which further related to their harsh couple interaction, and c) harsh couple interaction for males and females was related. In addition, husbands' harsh couple interaction toward wives was related to wives' lower cognition in later adulthood. This study shows the potential detrimental and long-lasting effect that felt economic pressures have on personal and marital distress in middle adulthood, influencing cognitive well-being in later adulthood. We presented this study at the 2022 annual meeting of the National Council on Family Relations in Minneapolis, Minnesota.

Although early life experiences can play a key role in understanding an individual's BMI and emotional distress over time and across generations, limited research explores these associations in one model and the possible explanations for these associations. For the next conference presentation, we examined body mass index (BMI) and emotional distress of two generations within the context of economic adversity. Specifically, we examined the association between economic adversity, BMI, and emotional distress, identifying the intergenerational continuity in the link between economic adversity and health outcomes. We analyzed generation one parent (G1) reports collected when their adolescent was 16 and adult children (G2)

reports when they were 41 years old. The findings showed that G1 economic pressure was associated with G2 BMI through G1 BMI and G2 economic pressure. G1 economic pressure was associated with G2 emotional distress through G1 emotional distress and G2 economic pressure. These results were presented at the 2022 biennial meeting of the Life History Research Society in Oxford, England. The study showed the intergenerational transmission of economic adversity, BMI, and emotional distress and identified unique mechanisms of psychological health outcomes and the effect of adverse family experiences over time.

We recently submitted a proposal to the 2023 biennial meeting of the Society for the Study of Emerging Adulthood investigating early economic adversity on emotional distress over time. With this study, we also tested how positive family support can boost individual-level resilience, which in turn can reduce emotional distress in emerging adulthood (EA, age 18-29). Findings showed that FSM pathways with parent emotional distress, predicted by family economic adversity, were related to emotional distress in adolescence, which continued to EA. The hypothesized pathways were significant, indicating that when parents were less emotionally distressed when the adolescent was 16, they received more support from parents in EA, were more resilient, and were less emotionally distressed at EA. This study highlights the long-lasting detrimental effect of family economic adversity on individual emotional well-being, as well as the importance of family support and individual resilience in EA that can ameliorate the negative continuity of emotional well-being over time.

Studies during this reporting period also revealed the unique family and intergenerational processes affecting psychological well-being and externalizing behaviors over the life span. Within two studies, we focused on alcohol problems and psychiatric disorders across two generations. The first study aimed to identify trajectories for binge and heavy drinking from adolescence through later adulthood and the similarities at age 40 between two generations. Intergenerational trajectories of alcohol problems when the adult child reaches the same age milestones as parents were identified. The second study focused on intergenerational transmission and continuity over time as an etiology of psychiatric disorders. The results showed: parent alcohol problems (age 16) to binge drinking (age 18) to alcohol problems (age 25) to substance use and anxiety disorders in adulthood. Parent distress (age 16) to adolescent distress (age 18) to distress (age 25) to affective and anxiety disorders. Adolescent alcohol use (age 16) to binge drinking (age 18) to alcohol problems (age 25) to substance use and anxiety disorders. Adolescent distress (age 18) to distress (age 18) to distress (age 25) to behavioral, affective, and anxiety disorders (age 31). Findings from these two studies identified the intergenerational transmission of alcohol problems, the impact of earlier adolescent risk factors on trajectories of binge drinking in emerging adulthood, and how these patterns of binge drinking in emerging adulthood impact mental, physical, and social consequences in adulthood. The first study was presented at the 2022 biennial meeting of the Life History Research Society in Oxford, England, and the second study was presented at the 2022 biennial meeting of the Society for Research on Adolescence.

The last study focused on older adults' sibling ties. Although the importance of sibling relationships increases as individuals enter into later adulthood, since older adults' other major social ties may no longer be available, a lack of studies explores sibling relationship qualities and their effect on older adults' well-being. Using the concept of ambivalence, defined as a simultaneous experience of positive and negative dimensions of relationship quality experienced in sibling ties, we investigated how sibling relationship quality is associated with older adults' psychological and physical well-being. Findings showed that older adults who felt more ambivalent toward their siblings reported poorer psychological well-being. This link was only significant with same-gender siblings, not with mixed-gender siblings, and this association was stronger among brothers over sisters. Our study is one of the first to quantitatively explore older adults' simultaneous positive and negative feelings toward their siblings and found its association with older adults' emotional distress, showing that sibling relationship quality matters to psychological well-being in later adulthood. This study was presented at the 2022 annual meeting of the National Council on Family Relations in Minneapolis, Minnesota.

In this reporting period, no study aimed at objective 2 with a focus on food insecurity exacerbating the association between negative family context and process and health outcomes over time. In the following period, we plan to further develop studies for objective 2.

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

Nothing significant to report.

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

In the current reporting period, we increased knowledge of the impact of family economic context and family process over the lifespan affecting rural individual and family health. The outputs and progress of this project are important in that they identified unique, complex, and longitudinal pathways to health outcomes, emphasizing intergenerational continuity, transmission, and family relationships to reduce the mental and physical health problems in families who may be at a higher risk in the U.S.

The results from the project were disseminated at national and international conferences with hundreds of participants. Practitioners and policymakers will utilize the findings to inform and develop educational programming, clinical practices, and policies that affect rural family health and well-being. For example, we shared the findings of our studies with practitioners who work with rural audiences, as well as local, state, and federal elected officials or program administrators who have influence over policies that impact mental and physical health and family functioning.

This research project also provided training for future researchers or professionals, such as graduate students or undergraduate students pursuing graduate studies, with the mentorship of three senior researchers on the team. Specifically, undergraduate and graduate research assistants received training in working with a 32-year longitudinal data set, which included entering, merging, and cleaning data. The graduate students were also responsible for performing statistical analyses on most presentations and publications during this reporting year. Lastly, graduate students played active roles in preparing manuscripts and presentations to disseminate the findings in peer-reviewed journals and at national and international conferences.

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.

Other than the seven conference presentations listed above, a publication was supported by the project:

1. Lee, T. K., Wickrama, K.A.S., O'Neal, C. W., Neppel, T. K., & Reeb, B. (2022). Life transitions events and depressive symptom trajectories during young adulthood: The influence of adverse family and individual contexts in adolescence. *Developmental Psychology*. DOI: 10.1037/dev0001496

Servsafe® Food Protection Manager Certification

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7001460



2022 ServSafe® Food Protection Manager Certification

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

In the United States, it is estimated that each year 48 million people experience a foodborne illness each year, 128,000 people are hospitalized due to a foodborne illness, and 3,000 deaths result 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.

The ServSafe® training was provided by ten Human Sciences Food and Health Program Specialists. Over 2,018 Iowans participated in an 8-hour Servsafe® workshop about safe food handling practices. A total of 250 Servsafe® trainings were facilitated with participant representation from all 99 of Iowa's counties. This training educates foodservice 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 your target audience benefited from your project's activities.

Of the 2,018 participants who completed ServSafe® training, 1,418 (70.3%) of the participants were successful in passing the class and received food safety certification through the National Restaurant Associations' Servsafe® Program.

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

- **70.3%** (n=1,418) of all participants (n=2,018) 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 the broader public benefited from your project's activities.

Servsafe® is a food safety training program developed by the National Restaurant Association. This training educates foodservice workers about food safety guidelines that are recommended by the FDA Food Code. By training foodservice workers to learn how to safely handle food, Iowa consumers are protected from getting food poisoning, potentially preventing serious illness or death.

Improving the health span of aging adults through diet and physical activity.

Project Director

Sarah Francis

Organization

Iowa State University

Accession Number

1020745



Supporting Older Adults through Nutrition Programs and Training Future Professionals

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

As the population of aging adults continues to grow, better understanding of effective strategies aimed toward improving the health span is needed. Aging is a multifaceted area of study that is continually exploring how to promote health and well-being throughout the lifespan. An integrative, interdisciplinary approach toward healthy aging from the metabolic level to translational science is imperative as aging is influenced by our genetics, metabolic processes, environment, and lifestyle practices. In doing so, it is likely we will improve the health span (part of a person's life during which they are generally in good health) of aging adults.

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.

IMPACT:

During the past reporting period, over 10,000 older Iowans participated in community education and/or research programs that increased awareness of food security resources, promoted familiarity with healthy lifestyle practices, and assessed program satisfaction and impact. The food security programs resulted in better nutrition choices and better understanding of SNAP.

SHORT-TERM OUTCOMES:

This work has resulted in the procurement of three grants (~\$340K), two published peer-reviewed journal articles, three published research abstracts, one invited presentation, and one thesis. Our SNAP outreach program efforts promoted SNAP awareness among 7,000 older Iowans. We reached 321 older adults through the online Stay Independent: A Healthy Aging Series program which led to a significant increase in familiarity among participants with recommended lifestyle practices. The majority also reported being "very likely" to make the recommended lifestyle behavior after each lesson. A commodity and supplemental food nutrition education program reached about 4,000 older Iowans. Of those surveyed, 69.3 percent used the information provided to make food choices, 63.4 percent applied the budget tips, and 72.7 percent made at least one of the recipes at home.

MILESTONES:

- Created a Microsoft teams group that houses all NE1939 project related materials including the policy and procedure manual, common assessment tools and corresponding codebooks, and meeting minutes.
- We disseminated information and findings from this project to nutrition and aging professionals through many publications

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

During the past reporting period, over 10,000 older Iowans participated in community education and/or research programs that increased awareness of food security resources, promoted familiarity with healthy lifestyle practices, and assessed program satisfaction and impact. The food security programs resulted in better nutrition choices and better understanding of SNAP.

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

The information gathered as part of the needs assessment project is informing the creation of materials distributed nationally by the Nutrition and Aging Resource Center.

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.

Through this project we trained 5 graduate students and 7 undergraduate students. They acquired skills in quantitative research (e.g., data collection, data entry, analysis), qualitative research (e.g., conducting focus groups, analyzing focus group data, etc.), professional writing (e.g., manuscripts, abstracts, theses), laboratory skills and nutritional status assessment (e.g., DST, MNA), physical activity assessment, program delivery and program evaluation.

Iowa Rural Latino Family Project: Exploration of Individual and Family Influences on Health and Well-being

Project Director

Kimberly Greder

Organization

Iowa State University

Accession Number

1011809



Factors Shaping Health and Well-being Among Rural Iowa Latinx Immigrant Families

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

This is a final report for this project. This project examined the status of, and identified factors that influence health and well-being among rural Iowa Latinx immigrant families. Latinxs are the largest and one of the fastest growing ethnic minority groups in Iowa and are critical to the vitality and productivity of Iowa's agriculture and food production economies. However, they experience vast economic, educational and health disparities that compromise their quality of life and full potential to contribute to Iowa's communities.

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.

Goal 1: To examine individual and family influences on the health and well-being of Latino families in rural Iowa communities.

Throughout the time of this project, 432 interviews were conducted with Latina/o immigrant parents across six Iowa communities to gather data related to food security, depressive symptoms, financial stress, employment status, and COVID-19. Analyses of cross sectional and longitudinal data was conducted and presented to extension staff, faculty with research, extension and teaching appointments, undergraduate and graduate students and family serving professionals. Key project findings include:

1. Low-income Latino families that have young children are disadvantaged in terms of child health and access to health care, and low-income non-Latino white children's families are disadvantaged in terms of child behavior problems and maternal health and depression.
2. Clinically significant depressive symptoms among Latina mothers are related to transportation, health insurance, and health care access, and to food insecurity.
3. First-generation immigrant mothers have lower levels of acculturation, which may serve as a protective factor to depression and food insecurity, than U.S. born Latina mothers.
4. Families who are migrant workers and move back and forth between states face additional stress than those who have one residence.
5. Food security among rural Latino families is related to knowledge of community resources and money management skills and to WIC participation.

6. Physical environments of communities (e.g., cracked sidewalks, lack of parks and low-cost recreation facilities, cold weather) inhibit rural Latino families from being physically active.
7. Homes that promote healthful eating and activity and limited media usage are associated with lower body mass among children.
8. Identification as a Latina immigrant, the level of respect between co-parents, and the number of children who lived in the home were related to obesogenic behaviors.
9. Immigration policy directly influences families' capacity to access health insurance and/or governmental assistance, to obtain driver's licenses in order to travel to doctor appointments or work, to be employed, and to connect with others in their communities.
10. Geographic distance created challenges to providing and receiving support between Latina mothers residing in rural Iowa and their families' of origin residing in Latin America.
11. Workplace conditions and lack of access to adequate health care services placed Latinx immigrant parents at risk of being exposed to COVID-19, as well as spreading the virus to family members and others in their communities.
12. Faith, emotional and tangible supports from family members, friends and local churches, and adhering to health advice (e.g., wearing masks, social distancing as feasible, etc.) helped to safeguard families' health and well-being during the pandemic.

Goal 2: To disseminate study findings to enhance further research and to inform practice. Throughout the time of this project, findings were disseminated to 720 extension staff, family professionals and other researchers via an infographic, 5 peer reviewed papers, 20 peer reviewed conference presentations, 2 webinars, two dissertations, and three meetings with faculty at the University of Iowa who share similar research interests. One paper is under review, and two papers are under development.

Goal 3: To nurture future researchers and practitioners interested in Latino family health and well-being. Throughout the time of this project, training and mentoring was provided to 8 graduate and 12 undergraduate students (race/ethnicity: 4 white, 2 African American, 2 Asian, 12 Latinx) related to project data management, analysis, and dissemination of findings. Graduate students who were involved have become postdoctoral scholars (2), faculty at universities (4), research scientist at a university (1), and a leader in state government (1). Undergraduates who were involved have become graduate students (2) and family serving professionals (10).

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

Iowa State University Extension and Outreach staff and other family serving professionals increased their awareness of the strengths of and challenges facing Latinx immigrant families in rural Iowa communities and awareness of strategies to implement to support family well-being and health. Iowa State University Extension and Outreach staff have partnered with local organizations that serve Latinx families across 17 communities to engage Latinx families in human sciences, 4-H and other extension programming. Twenty university students (80% who identify as ethnic/racial minorities) have increased their knowledge and skills in conducting research and outreach education, and implications of findings for further research, practice and policy.

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

As a result of this project, 20 undergraduate and graduate students in Iowa have become better trained as researchers and practitioners and increased their ability to contribute to the future of Iowa as professionals and community members who can help inform decisions related to Iowan's health and well-being, workforce and economy. Family-serving professionals and informal and formal community leaders have increased their understanding of influences on Latinx family health and well-being and strategies to address barriers to Latinx family health and well-being. Findings from this project have informed the knowledge base regarding factors that shape the health and well-being of rural Latinx immigrant families.

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.

Changes in approach: During the COVID-19 pandemic we needed to pivot our data collection strategy and move from in-person to phone interviews. This change in data collection resulted in not being able to collect data on all variables we have in the past as some data required in-person data collection (e.g., body measurements- height, waist, weight), and we needed to shorten the interview protocol to avoid participant response burden.

Opportunities for training and professional development: Training and mentoring was provided to 8 graduate and 12 undergraduate students (race/ethnicity: 4 white, 2 African American, 2 Asian, 12 Latinx) related to project data management, analysis, and dissemination of findings. Graduate students who were involved have become postdoctoral scholars (2), faculty at

universities (4), research scientist at a university (1), and a leader in state government (1). Undergraduates who were involved have become graduate students (2) and family serving professionals (10).

Dissemination of results to communities of interest: Findings were disseminated to 720 extension staff, family professionals and other researchers via infographic, peer reviewed papers and conference presentations, and webinars. Findings related to COVID-19 vaccination uptake and concerns among rural Latinx immigrants have been shared with researchers at the University of Iowa Health Policy Center who are also examining COVID-19 vaccination among Iowans. **Published products that have a DOI:**

- (1) doi: [10.1007/s10834-022-09841-4](https://doi.org/10.1007/s10834-022-09841-4); (
- 2) doi: <https://doi.org/10.1007/s10566-019-09512-w>;
- (3) <https://doi.org/10.1177/1049732318816676>
- (4) doi: 10.1097/FCH.0000000000000193;
- (5) doi: 10.1007/s10566-017-9401-6

Critical Issue

Human Potential and Youth Development

Essentials to Child Care

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7001439



2022 Essentials to Child Care

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

According to the Governor's Child Care Task Force Report (2021), Iowa estimates that the childcare shortage costs the state \$935 million annually in lost tax revenue, absences, and employee turnover. 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.

In FY22, **100,079** total class certificates of completion were issued to Iowa early childhood teachers and providers for successfully completing at least one of the 12 Essentials to Child Care Program's online classes. 100% of participants completing each online class were required to successfully attain a minimum score of 80% accuracy or above on a knowledge-based quiz and identify at least one planned change or improvement in practice. Participation in the Essentials to Child Care Program has been added to state licensing requirements for all Iowa child care teachers and providers.

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 teachers 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.

Increased knowledge on how to create safe environments for young children

- 100% of participants (n = 8,930) 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 = 8,626) 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 = 8,478) 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 = 8,378) 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 = 8,220) 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 = 8,433) 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 = 8,139) 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 = 8,023) 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 = 8,759) 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 = 8,024) increased knowledge on supporting cultural diversity as measured on a post-course certification exam.

Increased knowledge on Understanding Homelessness

- 100% of participants (n = 8,014) increased knowledge on understanding homelessness as measured on a post-course certification exam.

Increased knowledge on Child Development

- 100% of participants (n = 8,055) increased knowledge on child development as measured on a post-course certification exam.

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 within Iowa communities.

Iowa Mental Health Education Program

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7001461



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). Similarly, NAMI reported that one in six youth aged 6 to 17 experience a mental health disorder each year. In Iowa, 37,000 youth ages 12 to 17 reported having depression. Stressors related to the COVID pandemic also played a role in the number of youth who indicated struggling with their mental health. A 2020 survey conducted by Harris Poll, and commissioned by the National 4-H Council, found that 7 in 10 teens are struggling with mental health in the wake of COVID-19. This study also found that 55% of teens say they have experienced anxiety, 45% excessive stress, and 43% depression.

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.

Iowa State University Extension and Outreach's implementation of the evidence-based Mental Health First Aid (MHFA) and Question.Persuade.Refer. (QPR) programs provide Iowans with critical information related to risk factors and warning signs of potential suicide. The programs teach Iowans about mental health and substance use concerns and how to actively engage in helping others with mental health concerns.

17 Human Sciences, 4-H Youth Development, and Agricultural and Natural Resources extension program specialists were engaged as MHFA (Mental Health First Aid) facilitators. They reached 534 participants in 33 virtual or in-person workshops. Each virtual workshop included six hours of instructor led education and two hours of virtual pre-work. In-person workshops included 7 to 7.5 hours of in-person instruction.

Eight Human Sciences program specialists, one Agriculture and Natural Resources Extension program specialist, and three county extension educators were engaged as QPR (Question. Persuade. Refer.) facilitators. They reached 823 participants in 50 virtual or in-person programs. Each virtual program lasted one hour, while in-person programs averaged around 1.5 hours.

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

QPR and MHFA participants' post-program survey responses indicated the following:

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

QPR Results

- 98.4 percent of program participants (616/626) rated their knowledge of, "How to ask someone about suicide" as medium or high, with 30.8 percent noting their knowledge as **medium** and 67.6 percent indicating their knowledge as **high**.

MHFA Results

- 74.7 percent of program participants (86/115) agreed or strongly agreed they could ask anyone whether they were considering killing themselves, with 33 percent indicating they **agreed** and 41.7 percent reporting they **strongly agreed**.

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

QPR Results

- 98.3 percent of program participants (618/629) rated their knowledge of local resources for help with suicide prevention as medium or high, with 28.1 percent indicating their knowledge as **medium** and 70.1 percent of rating their knowledge **high**

MHFA Results

- 69.6 percent of program participants (80/115) noted it was likely or extremely likely that sharing knowledge of local resources would help with suicide prevention, with 37.4 percent indicating it was **likely** and 32.2 percent reporting it was **extremely likely**.

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

QPR Results

- 99.4 percent of program participants (622/626) rated their knowledge of, "How to get help for someone," as medium or high, with 30.4 percent indicating their knowledge as **medium** and 69 percent rating their knowledge **high**.

MHFA Results

- o 60.9 percent of program participants (70/115) indicated it was easy **or** very easy to refer someone experiencing a mental health or substance use challenge(s) to a health professional, with 31.3 percent noting it was **easy** and 29.6 percent reporting it was **very easy**.

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

Iowa State University Extension and Outreach's implementation of the evidence-based Mental Health First Aid and Question.Persuade.Refer programs provides 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, Iowans are better prepared to engage in action to intervene and assist others before a mental health crisis leads to injury or death.

Mindful Teen

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7001766



2022 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 and thoughtful reflection while aiming to reduce youths' 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 corresponding journal. 26 ISU Extension and Outreach staff, volunteers, and school and community partners facilitated the sessions. The Mindful Teen program was implemented in Iowa reaching 300 teens.

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

60 youth participants completed a post-program evaluation. 90% of youth indicated (54/60) they "Strongly Agree or Agree" that they have a better understanding of how stress impacts their mental and physical state. 63% of respondents (38/60) indicated they "Strongly Agree or Agree" that mindfulness practices can help them create and maintain positive relationships with people. 78% of youth reported (47/60) they believe mindfulness practices can help their overall well-being. Two-thirds of post-program survey respondents (40/60) stated that as a result of engaging in the 4-H Mindful Teen program, with practice they believe they can better cope with stress and difficult emotions.

Corresponding Outcome Measure Statement(s): 50% of survey respondents will self-report they agree or strongly agree with the statement "As a result of the 4-H Mindful Teen workshop series, I have a better understanding of how stress impacts my mental and physical health" as measured on a post-course survey

- o 90%

Corresponding Outcome Measure Statement(s): 50% of survey respondents will self-report they agree or strongly agree with the statement "As a result of the 4-H Mindful Teen workshop series, I believe mindfulness practices can help me create and maintain positive relationships with people" as measured on a post-course survey

- o 63%

Corresponding Outcome Measure Statement(s): 50% of survey respondents will self-report they agree or strongly agree with the statement "As a result of the 4-H Mindful Teen workshop series, I believe mindfulness practices can help my overall well-being" as measured on a post-course survey

- 78%

Corresponding Outcome Measure Statement(s): 50% of survey respondents will self-report they agree or strongly agree with the statement “As a result of the 4-H Mindful Teen workshop series, with practice, I feel I can better cope with stress and difficult emotions” as measured on a post-course survey.

- 67%

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 physical 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



2022 Volunteer Income Tax Assistance (VITA)

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

Misinformation 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 \$220 in 2022, 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.

The Volunteer Income Tax Assistance (VITA) program provides free, accurate, and trustworthy tax preparation to families with low- and moderate-incomes. In FY22, three Human Sciences Extension staff trained and supported 128 community volunteers who successfully completed IRS certification examinations for tax preparation. VITA helped Iowans secure sizable refunds, created savings by providing free tax preparation fees, and helped Iowans access tax breaks through the Earned Income Tax Credit (EITC). Through outreach and administrative support, 17 county extension offices across Iowa assisted 2,450 Iowans with low- and moderate-incomes to free and accurate tax preparation and to access critical tax credits.

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

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

- There were **2,450** tax returns filed
- There were **17** total program sites
- There were an estimated **8,955** 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 **128** 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

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

Create economic impact in local communities where VITA is offered

- There was **\$4,478,637** in total refunds;
- There was **\$1,158,003** in EITC refunds;
- There was **\$268,202** value of volunteer time;
- There was **\$666,400** value of fees saved

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

Innovation in Reducing the Loss of Nutrients to Iowa Surface Waters

Project Director

Matt Helmers

Organization

Iowa State University

Accession Number

7000724



Combination of in-field and edge-of-field practices reduce downstream nutrient delivery

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

Iowa is second in the nation in agricultural revenue and agriculture, broadly defined, accounts for approximately one-fourth of the state's economy. However, the rich soils and intensive crop production also contribute to water quality concerns both locally and downstream.

There are two overarching goals of this project: Goal 1: Identify and evaluate in-field and edge-of-field practices that reduce the loss of nitrogen and phosphorus to Iowa waters. Goal 2: Assess the effectiveness of cropping systems, and in-field, edge-of-field and NI practices, on the hydrology and pollutant transport of different Corn Belt agricultural and urban landscapes via ecohydrological modeling.

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.

Drainage water quality monitoring and crop production monitoring continued at five study sites across Iowa. This work documents the impact of nutrient, crop, and drainage management on drainage water quality and crop yield. Crop year 2022 was again drier than the long-term average such that nitrate-N loss with the drainage system was lower than the long-term average at these sites. As a result of the lack of precipitation, the crop yields were a bit lower than normal as well. Overall results indicate 4R nitrogen management, cover crops, and prairie have the potential to reduce nitrate-N loss but to differing degrees. Synthesis work documenting controlled drainage performance was completed. This showed that across the Midwest U.S. controlled drainage has the potential to reduce nitrate-N delivery to the stream through subsurface drainage systems.

Water monitoring continued at four subsurface denitrification bioreactors across Iowa. This includes weekly grab sampling for nitrate-N concentrations. Results have indicated that bioreactors are an effective practice for reducing nitrate-N delivery to downstream waters.

A blind inlet with phosphorus-sorbing amendments to the gravel infill was installed in an ISU research field as a replacement for a standard riser-style surface inlet, and water samples were taken from the ponded water and the drainage water. Data are being analyzed to determine if this practice would address the high concentrations of dissolved reactive phosphorus we had previously observed in standing water in farmed prairie pothole depressions.

Ongoing research investigated the effectiveness of saturated buffers in removing nitrate at 20 Iowa sites, with over 90 site-years of data collected to date. Due to regional drought, locations in NW Iowa received no tile drainage throughout the reporting period. All saturated buffers receiving flow were effective in removing nitrate from tile drainage, with the average annual nitrate load removal ranging from 6 to 120 kg-N. Annual removal effectiveness (total nitrate removed in the saturated buffer divided by the total nitrate delivered to the tile outlet), ranged from 18%-98%. Initial N-removal data was collected at three saturated buffers with novel automated control structures. These saturated buffers were installed in flatter landscapes and require seasonal management to avoid crop damage from backing water up into the field. Water level within control structures is measured using near-range radar sensors and converted to flow using calibrated stage-discharge relationships. The control structures were programmed to be open from April 20 – May 20 to allow for planting in adjacent fields. An objective of this research is to assess mass N load bypassed under this management.

A long-term study was initiated to evaluate nitrogen and phosphorus flow-weighted concentrations (FWC), loads, yields, and fractions among five locations at various scales in a central Iowa HUC12 watershed. An additional objective is to assess the applicability of turbidity as a surrogate for particulate phosphorus (PP) and suspended sediment concentrations (SSC) to better understand the interplay between phosphorus and sediment along the channel corridor.

Initial results were greatly impacted by low flow conditions during the first year of the study. Significant differences were observed in flow-weighted concentrations and loads of nitrogen and phosphorus. As you increase watershed size, there is an observed decrease in nitrate and total nitrogen concentrations. Nitrate comprises the majority of total nitrogen, with the ratio increasing with watershed area up to 2423 ha, before decreasing with increasing contributing area. Total phosphorus concentrations and loads are generally highest at sites > 2423 ha. Total reactive phosphorus makes up the majority of total phosphorus at most locations and its ratio increases with watershed area. A preliminary evaluation suggests that turbidity may serve as a suitable surrogate for suspended sediment and particulate phosphorus.

Ongoing efforts continue a decade-long field study of bank erosion measured with erosion pins distributed throughout Onion Creek, a 3rd-order watershed in central Iowa. Study banks located throughout the 57 km² watershed were visited 76 times between 2011 and 2021 to track the spatial and temporal distribution of bank erosion. Measurements from pinned study banks were upscaled using the results of two rapid visual streambank assessments and Stage I of the River Styles Framework. Water levels from bridge-mounted water stage sensors and a synthetic rating curve were used to construct a hydrological record for the 10-year study period. Throughout the study period, estimated bank erosion introduced over 30,000 Mg of sediment and 11 Mg of phosphorus to the channel, with inputs concentrated along the main stem. Mean bank recession rates ranged from 4.1 to 19.3 cm/year among the study periods, with the highest rate during the most hydrologically active study period. These results highlight the importance of long-duration studies with sub-annual temporal resolution and broad spatial extent in accurately quantifying erosion.

SWAT models have been constructed for the Des Moines River Basin (DMRB), North Skunk River Basin (NSRB) and South Skunk River Basin (SSRB) in support of the Iowa UrbanFEWS project (see study published in *Frontiers of Big Data*) as described in the study published in *Science of the Total Environment* (STOTEN). Initial development and hydrologic testing of these models, as a function of land use, management practices and other inputs, are described in this study. Strong results were obtained in this first application without performing any calibration or validation for the SWAT simulations.

A revised suite of crop parameters has also been developed for 28 fruit and vegetable crops as part of the Iowa UrbanFEWS research. An initial application of these fruit and vegetable crops in SWAT for the DMRB is reported in a study that includes an interface with a Life Cycle Assessment (LCA) model: https://www.card.iastate.edu/ag_policy_review/article/?a=150. Both baseline and future water quantity/quality impacts are reported, including nitrogen and phosphorus indicators.

A report was compiled and submitted for the Environmental Defense Fund (EDF) describing alternative flood and ecohydrological models that could be used to evaluate the impact of natural infrastructure (NI) practices for the Mississippi-Atchafalaya River Basin (MARB). The National Agroecosystem Model (NAM), described in the *Journal of the American Water Resources Association* (JAWRA), was recommended as the most viable modeling tool for simulating the effects of NI practices distributed across the MARB. Preliminary NAM output has already been used in a GIS screening model designed to evaluate potential NI practice placement in the MARB (citation for study provided below).

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

Our work on drainage water quality has informed farmers of the potential for 4R nutrient management and cover crops to reduce nitrate-N loss. These individuals desire data on the performance of these practices when thinking about implementation.

With the controlled drainage synthesis work there was an increased knowledge about the performance of this practice across the Midwest U.S. this was one of the largest and most comprehensive systems studies on this topic.

Bioreactor performance data have been useful to stakeholders in the state of Iowa that are actively working to increase the rate of implementation of this technology.

The modeling work for the DMRB, NRSB and SSRB revealed that establishing accurate representation of subsurface tile drainage, nitrogen fertilizer application rates and other key inputs was vital for obtaining the best results. The results also confirmed that additional calibration and validation of the SWAT models is needed to refine the hydrological predictions of the models, and to establish the most accurate representation of nutrient and sediment exported from cropland and other landscapes to the respective stream systems.

Establishing the best parameter value choices for the fruits and vegetable crops was challenging due to a lack of measured growth/yield data for Corn Belt conditions. However, we have gained confidence that we are depicting those crops accurately in SWAT, which will support the ability to investigate innovative cropping system scenarios in central Iowa.

The EDF modeling review report provided important insight into which models would be the most flexible and effective for simulating NI practice impacts across the MARB region. The NAM system, with SWAT+ serving as the core simulation engine, provides a strong foundation for simulating NI interventions and other practices in the MARB region. This is true both in the context of direct simulations with SWAT+/NAM and using output from the system to support the MARB GIS model.

The EDF modeling review report provided important insight into which models would be the most flexible and effective for simulating NI practice impacts across the MARB region. The NAM system, with SWAT+ serving as the core simulation engine, provides a strong foundation for simulating NI interventions and other practices in the MARB region. This is true both in the context of direct simulations with SWAT+/NAM and using output from the system to support the MARB GIS model.

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

The results of the drainage water quality monitoring data have been used in public presentations to highlight that there are practices that can be used to reduce nitrate-N loss to downstream waterbodies. This changes the knowledge of interested stakeholders.

The bioreactor performance data has been shared with various stakeholder groups in Iowa such that many citizens in Iowa that are concerned with nitrate-N delivery gain a better understanding of the performance and potential of subsurface drainage denitrification bioreactors.

One important outcome of this work has been the rate of saturated buffer adoption and transformation of the delivery model for practice implementation. Findings from the saturated buffer research partnership have provided the underpinnings for the rapid adoption of the practice throughout the drained landscape in the Midwest. The work has provided the web-based tools to identify potential project sites and developed the siting and design criteria to optimize nutrient removal. Technology transfer

efforts at multiple scales have translated the research into scaled-up implementation of these practices in priority watersheds involving strong public-private partnerships. Intensively monitored research sites now cumulatively provide nearly 100 site-years of data that document practice performance.

The SWAT models developed for the Iowa UrbanFEWS research provide a firm foundation for representing watershed-level impacts of adopting table food crops in the Des Moines metropolitan area. These models are also key components of the overall integrated modeling system that has been developed for the project.

The EDF report confirmed the best choice of modeling tools for representing NI practices across the MARB. The NAM system output has proved very useful in conducting MARB GID modeling.

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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[doi:1002/jeq2.20281](https://doi.org/10.1002/jeq2.20281)

Iowa Master Conservationist Program

Project Director

Keli Tallman

Organization

Iowa State University

Accession Number

7001618



2022 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 ecosystems within the state of Iowa. 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.

Growth of the Master Conservationist Program continued during 2022 as 17 course offerings were organized throughout the state. This exceeds the number of offerings in 2021, and has now become the biggest year for the program since the redesign in 2017. The 2022 offerings were organized and led by a the state extension wildlife specialist, the natural resources field specialist, and 24 extension districts with support from local conservation organizations.

In 2022, 252 people completed the course. The standard course format consists of 12 hours of in-person educational contact time and 19 hours of online educational contact time; a total of 7,812 educational contact hours were earned in 2022. In-person sessions were organized locally with variable arrangements for meeting times and durations. Offerings mostly consisted of seven in-person meetings, with one offering opting for 6 in-person meetings and one offering opting for 5 in-person meetings. Eight offerings were started and completed during the spring and early summer (April-July), three offerings spanned the summer (April- September), four offerings were started and completed during the fall (August-October), and two offerings began in the Spring and ended in the Fall (March-November).

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.

Pre-course and post-course assessments were completed by 120 and 121 participants, respectively. To predict the impact of the program on changes in land use and resource stewardship behaviors, participants were asked if they planned to implement practices or principles learned in the Master Conservationist Program on land they own or have influence over. 97% of respondents replied "yes" indicating they did plan to apply lessons to land they owned or had influence over. 84% of respondents indicated they intended to apply lessons from the class to their "Home yard or farmstead." These respondents reported an intent to impact 1,161 acres of home yards or farmsteads. Respondents also declared an intent to impact a number of other land uses including aquatic ecosystems (41% of respondents, 691 acres), city parks or public natural areas (34% of respondents, 6,230 acres), cropland (20% of respondents, 3,906 acres), forested areas (39% of respondents, 893 acres), pasture (28% of respondents, 937 acres), prairie areas (39% of respondents, 556 acres), and other land uses (5% of respondents, 5 acres). In total, respondents indicated an intent to impact 14,379 acres of land with lessons from the class.

Participants were asked to rate their overall satisfaction on four course elements and demonstrated high satisfaction. Over 80% of all respondents rated their satisfaction as "satisfied" or "extremely satisfied" on each of the elements; online materials (95.0%), technical materials covered during in-person sessions (92%), networking opportunities (87.5%), and organization of the course experience (96%).

95% of respondents reported the online materials "improved their learning experiences in the program" while 5% indicated they "had not impacts on learning in the program." 118 respondents answered the question "Would you recommend enrolling in this program to friends or family," with 97% saying yes and the remaining 3% saying "maybe." 99% of respondents indicated they believed the program was successful in meeting the goal of creating a community of passionate conservationists.

Of the 121 participants who completed the post-course survey, participants reported the following:

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.

99%

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



2022 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 water bodies, 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 water bodies. 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 2022, two academies were held to address current watershed coordinator and conservation practitioner needs. The Spring 2022 Academy, attended by 36 coordinators and conservation professionals, focused managing perennials on farmland for the benefit of habitat, wildlife and profitability. It also included presentations on persuasive communication and working with the media. The Fall 2022 Academy, attended by 35 coordinators and conservation professionals, focused on soil and nutrient management, machinery, and working with partners.

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

Pre and post self-assessments were completed by 39 participants and are used to evaluate short-term change in knowledge and self-efficacy. Coordinators are also asked about future topics and/or speakers that would be of particular interest. All presentations are shared online so that coordinators can continue to refer to them. At both academies, 95% of attendees

indicated an increase in knowledge related to conservation practices, programs, and outreach strategies and also stated they would share information they learned with colleagues. Seven attendees signed up to be a part of the Watershed Academy Advisory Council, and ten watershed coordinators were accepted into the Land Stewardship Leadership Academy.

Measure #1: Percentage of participants who self-report an increase in three different knowledge indicators related to conservation practices, programs, and outreach strategies.

- 95%

Measure #2: Percentage of participants who report an intention to share what they learned at the Watershed Academy with their colleagues and office.

- 95%

Measure #3: Percentage of participants who report involvement in local and statewide watershed leadership activities.

- 100%

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 water bodies across Iowa.

Population ecology and conservation of vertebrate and invertebrate organisms

Project Director

Stephen Dinsmore

Organization

Iowa State University

Accession Number

1022490



Advancing wildlife conservation through applied research

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

We conducted applied research in partnership with a variety of conservation professionals, private landowners, and other stakeholders throughout North America to inform conservation and management of birds and other wildlife species. We applied modern research techniques to answer important questions and then sought to communicate our findings through presentations, outreach materials, and peer-reviewed research.

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.

Work on this project is organized under three main objectives. Here are the major accomplishments under each objective.

Under Objective 1: Our work with multiple partners continues to investigate wildlife populations through detailed demographic studies. Under this objective we continued to work with economically important hunted species (White-tailed Deer, Northern Bobwhite, and Ring-necked Pheasant) and conservation priority species (Mountain Plover, migratory shorebirds, Monarch butterfly, and wetland birds) in an effort to better understand the status of those species with a goal of improved population management. We continue to estimate residency times of Least Sandpipers at flood storage reservoirs in Iowa to help better manage water levels to benefit birds and other wildlife and reduce nitrogen concentrations. Our shorebird work expanded into the Arctic where we are working to provide nest survival estimates free of observer bias due to nest checks; nest visits may be lowering avian nest survival. We have ongoing research evaluating methods for estimating fall abundance of Northern Bobwhites in southern Iowa, in collaboration with the Iowa DNR. We also expanded our work using satellite GPS receivers and remote download GPS tags to study local and annual movements of the Mountain Plover and several species of gulls. Lastly, we initiated new work on the population ecology of the Blanding's Turtle in Iowa and the Arctic Fox in remote Alaska.

Under Objective 2: Our work with natural resource management agencies continues to demonstrate how wildlife respond to local and landscape level habitat conditions on Iowa's public and private lands. We continued to implement the Multiple Species Inventory and Monitoring (MSIM) program to monitor Iowa's wildlife and understand how they respond to local and landscape habitat conditions. This work had important implications for habitat management and survey methodologies to benefit Blanding's Turtles and Monarch butterflies in Iowa. We provided advice on managing flood storage reservoir water levels to benefit migratory shorebirds and other waterbirds under the Sustainable Rivers Program (SRP), a cooperative effort between the

U.S. Army Corps of Engineers and The Nature Conservancy. This work used the waterbird community and seasonal emergent vegetation as the primary responses to changes in pool levels and will be expanded to include measures of invertebrate responses and satellite tracking of shorebirds. We finalized and published research on duck broods in wetlands in intensively farmed landscapes in Iowa, Minnesota, North Dakota, and Iowa. We also started research evaluating how waterbirds use wetland constructed to address water quality issues in Iowa. Thus, our work continues to have broad impacts on how we conserve and manage Iowa's wildlife for the enjoyment of future generations; we also continue to influence wildlife management decisions outside of Iowa.

Under Objective 3: Our research in this arena seeks to understand how birds use working agricultural landscapes and best practices to promote coexistence between agriculture and avian populations. We have research ongoing in collaboration with the USFWS, Iowa DNR, and Ducks Unlimited to understand how waterfowl use wetlands in cropland-dominated landscapes during spring migration and the breeding season. We finalized and published research examining bird use of cover crop fields in southern Iowa. We commenced research supported by Natural Resources Conservation Service examining northern bobwhite responses to Environmental Quality Incentives Program implementation throughout Iowa. We use a variety of research methods to answer these questions, and disseminate findings through extension education to farmers and others in the agriculture community.

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

Our target audience benefits from our work through collaborative research and outreach efforts, acquisition of scientific knowledge related to project objectives, and by project outputs. Our target audiences include diverse local, regional, and national wildlife scientists and managers, Iowa citizens. Specific target audiences covered by this report include the Iowa Department of Natural Resources (Wildlife Bureau), Lands and Natural Resource Operations, National Fish and Wildlife Foundation, the U.S. Army Corps of Engineers, regional, national, and international ornithologists, shorebird ecologists in the Great Plains and Alaska, upland game biologists and researchers, U.S. Bureau of Land Management, and the U.S. Fish and Wildlife Service. We engaged in several efforts to deliver science-based knowledge to people. Formal classroom instruction activities included one undergraduate course (Principles of Wildlife Conservation) and one graduate course (Avian Ecology). In addition, the group gave talks to three local Audubon chapters, state organizations including the Iowa Chapter of The Wildlife Society and the Iowa Ornithologists' Union, national talks at meetings of The Wildlife Society and the American Ornithological Society, and gave guest lectures in relevant courses at Iowa State University. We shared project findings through graduate student theses and dissertations, peer-reviewed manuscripts, technical reports, Extension publications, and other diverse media. During the current reporting period this included conference presentations (16), peer-reviewed journal articles (6), and book chapters (1).

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

Our work directly relates to many important natural resource priorities. For example, our flood control reservoir work has the potential to impact the timing and extent of pool elevation alterations to benefit wildlife as well as fisheries, boating, and other forms of recreation while continuing to provide flood control benefits. Our work with important game species provides solutions that directly impact our understanding of the number of individuals in managed populations, how management actions (habitat alterations, changes in harvest regulations, etc.) affect those populations, and how those populations can be managed for the future. We continue to provide estimates of important demographic parameters (survival, nest success, dispersal, etc.) that are necessary to implement species conservation plans, we directly estimate biodiversity to provide a community assessment, and we work with stakeholders to develop scientifically sound conservation plans. Our conservation work with many non-game species seeks to apply research findings to at-risk populations to promote species recovery and persistence. Our research on wildlife use of wetlands constructed for water quality dovetails with ongoing efforts to address systemic challenges of nutrient pollution in surface waters throughout the corn belt. Finally, we place a special emphasis on finding ways to sustain wildlife in working agricultural landscapes through the use of innovative conservation measures (buffer strips, improved water quality, etc.).

Identifying factors responsible for the occurrence, distribution, and impacts of disease in wildlife populations

Project Director

Julie Blanchong

Organization

Iowa State University

Accession Number



Progress developing genomic tools for deer and disease management, identifying prevalence of lymphoproliferative disease in turkeys, and documenting trends in bat populations

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

Wildlife diseases are receiving increased attention due to awareness of the involvement of wildlife in diseases affecting humans and domestic animals, recognition that disease can have important impacts on wildlife conservation, and appreciation that disease is an important ecological factor shaping population and ecosystem characteristics. The purpose of this research is to enhance the management and conservation of wildlife populations for their benefit and to protect the role they play in ecosystem integrity and human health and well-being. The objective is to investigate factors associated with the occurrence, distribution, and impacts of disease in wildlife populations.

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 results of this research are contributing new knowledge of factors affecting the transmission, distribution and impacts of disease. Progress in each of three focal areas is described below.

a) Development of genomic tools to enable improved white-tailed deer and disease management

Hundreds of millions of single nucleotide polymorphisms (SNPs) that were identified through white-tailed deer genome resequencing were filtered to identify 600,000 SNPs to place on a high density SNP array. Approximately 60,000 of the best performing SNPs were selected for development of a medium density array. Preliminary analysis of data collected for free-ranging white-tailed deer from across their eastern geographic range genotyped on the high density array (480 deer) and the medium density array (1536 deer) has revealed that these tools are useful for generating meaningful insights into deer population genetic structure across a large portion of their range. Analysis also revealed many SNPs that appear to be under selection and will potentially be useful for identifying genetic associations with local adaptation and disease susceptibility. As a result, we now have two new genomic tools to serve as next generation genomic resources available for researchers and managers to use to better understand and manage white-tailed deer populations and the diseases that affect them (e.g., chronic wasting disease). A webinar was hosted in spring of 2022 to provide details about these tools and results of preliminary data analyses to interested wildlife resource managers (key end users of the tools). Development of a 3rd tool – a GTseq tool – is currently under development in a collaborator's lab. Preparation of manuscripts associated with this work is in progress.

b) Investigation of factors influencing the occurrence of a newly identified virus in wild turkeys

Surveillance for lymphoproliferative disease virus (LPDV) in wild turkeys in Iowa was completed using a total of 1022 turkey samples donated by hunters during the spring 2020 and 2021 harvests in Iowa. DNA was extracted from turkey legs and birds were screened for LPDV using two different genes to detect the presence of viral DNA. The first objective of the work was to compare LPDV detection rates using PCR amplification of two different regions of the viral genome (gag and LTR). Results indicate that the LTR region detected cases of LPDV that the gag region – the primary region used for LPDV detection in published studies – fails to detect. At least in Iowa, using the gag region for LPDV surveillance results in an underdetection of the frequency of LPDV and LTR – though also not perfect – appears to be a better choice. We recommend future studies investigate if this is also true in other areas of North America where LPDV occurs in wild turkeys. The second objective of the project was to identify spatial patterns in prevalence, ecological correlates associated with occurrence of the virus, and relationships between strains identified in Iowa and strains found elsewhere in North America to better understand viral distribution and potential importance of this virus to wild turkey populations. We found LPDV was distributed in turkeys across Iowa. We found a high diversity of viral strains – based on the gag region of the genome. We found no spatial clustering of LPDV strains within Iowa and no particular clustering of Iowa strains with strains any particular region of North America where LPDV has been detected in wild turkeys. There were also no strong ecological correlates associated with probability of infection. These results suggest LPDV is widespread in Iowa and has likely been present for a considerable period of time. This work was conducted by a graduate student who completed her MS degree in spring of 2022. Her thesis is available through the Iowa State University library. Preparation of manuscripts associated with this work is in progress.

c) Identification of spatial and temporal variation in Iowa bat populations to better understand likely impacts of White-nose Syndrome

Bat acoustic monitoring data were collected by volunteers on mobile drive transects and at stationary sites. This effort was initiated in 2013 and occurs each summer relying heavily on volunteers to collect the data. Data were analyzed to identify spatial and temporal variation in bat activity across Iowa. In summer of 2022, we expanded the scope of the project by adding two new

North American Bat Monitoring Program priority grid cells for a total of 24 mobile transects and 22 stationary sites across Iowa. This is a citizen science based project offering Iowans interested in wildlife the opportunity to contribute to collection of data aimed at improving their conservation and management. Data will contribute to state and national efforts to monitor bat population trends and impacts of threats to bats including White-nose Syndrome. Reports of findings are provided to the Iowa Department of Natural Resources, the US Fish and Wildlife Service, and to volunteers.

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

The audience reached during this period of the project includes academic peers, wildlife managers (end users of the information for management decisions), and the public. Specifically, these include the Iowa Department of Natural Resources, managers at several US Natural Resource agencies, the US Geological Survey, the US Fish and Wildlife Service, and Iowa citizens. The results of this research are benefitting the target audience of the project's activities as described below.

a) Development of genomic tools to enable improved white-tailed deer and disease management

The 3 genomic tools that have been/are being developed will be available for researchers and managers to use to serve as next generation genomic resources to better understand and manage white-tailed deer populations and the diseases that affect them (e.g., chronic wasting disease). These tools will make collaboration among researchers and state agencies more efficient and effective as the results generated by these new tools are easier to compare and combine than data generated using traditional genetic tools.

b) Investigation of factors influencing the occurrence of a newly identified virus in wild turkeys

Data on the frequency of lymphoproliferative disease (LPDV) in wild turkeys, insight into the effectiveness of various methods of detection, and identification factors associated with risk of infection, and genetic variation among strains provides natural resource managers and researchers with knowledge about the potential effectiveness of different methods for surveillance for this virus and information that may contribute to understanding the potential relationship between this virus and recent declining trends in wild turkey populations.

c) Identification of spatial and temporal variation in Iowa bat populations to better understand likely impacts of White-nose Syndrome

Data on bat activity across Iowa are contributing to state and national efforts to monitor bat population trends, identify impacts of White-nose Syndrome and other threats to bat populations, and prioritize management and conservation activities.

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

The broader public benefits from these activities in the following ways:

1. The 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation estimated that Americans that participated in fishing, hunting and other wildlife-associated recreation spent more than 155 billion dollars on equipment, travel, licenses, and fees. Population declines and associated loss of revenue would negatively affect agencies' abilities to manage wildlife for citizen stakeholders and may also negatively affect livelihoods of those supported by these activities. Development of tools to better manage deer and their diseases, as well as providing insight on the distribution of lymphoproliferative disease virus (LPDV) in wild turkeys, will improve the management these diseases and wildlife populations for the continued benefit of citizen stakeholders.

2. The economic value of insectivorous bat activity in corn crop systems has been estimated to be more than one billion US dollars globally. Loss of these services from bats due to White Nose Syndrome (or other sources of mortality such as wind turbines) could generate additional costs for agricultural producers. Data on bat population trends provide managers insight into areas of Iowa and species of bats that would benefit from actions to mitigate negative outcomes associated with bat population declines.

3. The bat acoustic monitoring project is a citizen science project offering Iowans interested in wildlife and science the opportunity to learn about bats as well as to contribute to collection of data aimed at improving their conservation and management.

Fundamental Processes That Promote Sustainable Crop Production in Healthy Soils

Project Director

Michael Thompson

Organization

Iowa State University

Accession Number

1020365



Predicting the Impacts of Fertilization, Soil Water Content, and Gully Erosion on Soil Health

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

This project seeks to assess how soil management practices affect soil's biological, chemical, and physical properties. Healthy soils have properties that will sustain their use for effective crop production for future generations. One aspect of our project is to learn how the activity of enzymes in the soil can affect nutrient cycling in soil under different cropping systems. Another aspect is to better predict the impacts of soil tillage and soil compaction on soil water retention curves. A third aspect is to develop better ways to predict where ephemeral gullies will occur when soils are eroded.

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.

Extracellular soil enzymes play a key role in soil organic matter decomposition and nutrient cycling. But previous studies have reported mixed effects of nitrogen fertilization on potential enzyme activity in soils. We sought to investigate the impacts of nitrogen fertilizer on microbial biomass, nitrogen-cycling enzymes, and other soil properties in two cropping systems (continuous, annual maize vs. a perennial biofuel crop, miscanthus). We hypothesized that nitrogen-cycling enzymes and microbial biomass would be increased in the perennial system. We also hypothesized that potential enzyme activity and microbial biomass would generally increase as nitrogen fertilization increased. We found that nitrogen fertilization had no effect on microbial biomass in either cropping system. Similarly, nitrogen rate did not consistently affect activity of three nitrogen-cycling enzymes, with the exception of tyrosine aminopeptidase. In that instance, nitrogen fertilizer suppressed enzyme activity, but only at the highest rate of the amendment. On the other hand, the miscanthus crop did increase water-holding capacity and soil organic matter by an average of 14% and 4%, respectively, compared to annual maize -- across all the nitrogen rates. These results suggest that other factors, such as clay concentration in the soil or soil pH may have had a greater impact on enzyme activity than nitrogen fertility alone.

A soil water retention curve is the relationship between soil water content and soil water matric potential. There are similarities between soil water retention curves and soil thermal conductivity versus water content curves. In this study, we used 10 selected soils to explore the relationship between soil water retention curve model parameters and thermal conductivity model parameters. The saturated water contents were set equal to soil porosity, the air entry values were determined from the particle size distribution and organic carbon content, and the residual water contents were estimated from thermal conductivity measurements. A new method was developed to estimate soil water retention curves from thermal conductivity measurements and selected soil properties. The new method was evaluated by estimating water retention curves for six soils and comparing the estimates to directly measured water retention curves. The new method performed well with root mean square errors of estimated water content values ranging from 0.015 to 0.052 cm³ cm⁻³ and bias values ranging from -0.009 to 0.040 cm³ cm⁻³. Thus, the new method was able to accurately estimate soil water retention curves from thermal conductivity curves and selected soil property values.

Across sections of four states (Iowa, Missouri, Nebraska and Kansas), we are building an extensive aerial image data set of agricultural land with georeferenced ephemeral gully locations. In these areas, digital elevation models are constructed using data collected by LiDAR (Light Detection and Ranging using pulsed laser light) that allow us to predict the locations of water flow paths. This regional data set extends across multiple major land resource areas and is being used as a rigorous test of our recently developed approach for predicting ephemeral gully locations in agricultural fields.

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

We presented posters at a national scientific meeting, and we published papers in scientific journals.

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

Our activities will improve models that soil scientists and conservationists use to make predictions of changes in biological, chemical, and physical properties of soils as a result of agricultural activities. Such changes are predicted using computer models designed and calibrated using the functions developed in research like ours. When farmers and other land managers can predict the impacts of their practices, such as tillage or choosing annual vs. perennial crops, they can make better decisions in optimizing their practices for long-term sustainability.

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.

There were no major changes and we did not encounter major problems in this year of the project.

We have listed below some of the research publications that were supported by the project.

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. doi.org/10.1016/j.still.2021.104948.

Annan Yang, Chunmei Wang, Qinke Yang, Guowei Pang, Yongqing Long, Lei Wang, Lijuan Yang, Richard M. Cruse. 2022. Choosing the right horizontal resolution for gully erosion susceptibility mapping using machine learning algorithms: A case in highly complex terrain. *Remote Sensing* 14, 2580. <https://doi.org/10.3390/rs14112580>.

Shengmin Zhang Xing Han, Richard M Cruse, Xingyi Zhang, Wei Hu, Yue Yan, Mingming Guo. 2022. Morphological characteristics and influencing factors of the permanent gully and its contribution to regional soil loss based on a field investigation of 393 km² in Mollisols region of northeast China. *Catena*. <https://doi.org/10.1016/j.catena.2022.106467>.

Zhou, P., Sheng, H., Gu, Y., Yin Z., Xue, Y., and Thompson, M.L. 2022. Consistent inter-annual reduction of rice cadmium in 5-year biannual organic amendment. *Sci. Total Environ.* 807, Part 3, 151026. <https://doi.org/10.1016/j.scitotenv.2021.151026>.

Costs and Benefits of Natural Resources on Public and Private Lands: Management, Economic Valuation, and Integrated Decision-Making

Project Director

John Tyndall

Organization

Iowa State University

Accession Number

1014676



Advancing spatial financial decision support tools for conservation planners

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

Accounting for the full costs of water quality management is critical to developing appropriate budgets and determining optimal allocative pathways regarding available resources. Furthermore, because the costs of watershed scale water quality management are expected to be very high, being able to examine cost-effectiveness as part of conservation planning is important. Despite the importance of up-to-date, comprehensive and transparent financial information for conservation planning purposes, this data has historically not been generated and made available for broad use until now. Our work has created 1) key financial data sets for regionally relevant water quality best management practices, and 2) the analytical tools that use these financial data to variously aid conservation planners incorporate critical economic information into conservation planning and on-the-ground watershed projects.

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 created two spatially explicit, watershed scale (at Hydrologic Unit Code 12 scale watersheds), decision support tools called the Financial and Nutrient Reduction Tracking tool (FiNRT; "fine art") and the Conservation Optimizer (CON-op) that add significant analytical capacity to the Agricultural Conservation Planning Tool (ACPF). The ACPF identifies hydrologically

determined spatial opportunities for the placement of specific water quality best management practices (BMPs). The FiNRT assesses 1) nitrate-N loss reduction at field and watershed scales, 2) estimates the direct and relevant opportunity costs of conservation scenarios featuring various BMPs, and 3) is capable of conducting complex financial analyses such as cost-effectiveness, tradeoff analysis, and with the CON-op add on, conservation budget optimization. Specifically, FiNRT calculates total annual costs (direct and opportunity) of a conservation scenario, total number of fields affected, and two types of cost-effectiveness: one based on estimated total percent nitrate load reduction and the other based on cost per unit load reduction. Cost-effectiveness assessments are objective measures of allocative efficiency and, in this case, are calculated by dividing the total present value cost of a BMP by total biophysical effect associated with the use of the conservation practice across the relevant time period. Comprehensive conservation practice enterprise budgets and discounted cash flow techniques are used to calculate the direct, long-term annualized costs for BMP installation and management over a given time period. Where relevant, land use opportunity costs are spatially determined according to Major Land Resource Area-relevant, area-weighted-average crop productivity indices and land rent relationships. The tool quantifies the nitrogen requirements for each field, based on 6-year land-use data, and evaluates the proportion of that nitrogen likely to be lost from the field as nitrate load via leaching. Output information generated by the FiNRT includes: nitrate-N load reductions, total direct and opportunity costs, and cost-effectiveness (total annual cost divided by load of nitrate-N reduced) for each scenario at practice, field, and watershed scales. Cost-effectiveness in particular has been demonstrated to be a necessary decision criteria for maximizing conservation impact across a range of activities, which is particularly critical when financial and technical service resources are scarce. Currently the FiNRT has financial and nitrogen load default data for Iowa and Minnesota. Financial data sets (2022\$) for Iowa, Minnesota, and Illinois have been developed. These data sets involve comprehensive enterprise budgets for eleven water quality Best Management Practices (BMPs) that were identified in the Iowa Nutrient Reduction Strategy for various use as appropriate in-field (e.g., cover crops, prairie strips, grass waterways, WASCObS), edge of field (e.g., riparian buffers, filter strips, saturated buffers), or downstream positions (e.g., bioreactors, nutrient removal wetlands, farm ponds). These budgets were then used to calculate the direct annualized costs of establishing, short and long-term managing, and replacement of practices over a 20-year period using discounted cash flow techniques. The state of Ohio is next on the list for financial data development. These decision support tools are the only ones of their kind available to conservation planners in the US Cornbelt region.

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

Too soon to tell but we anticipate that the FiNRT and CON-op will become fully adopted in future conservation planning initiatives that occur at watershed scales. The FiNRT (IA and MN software versions) have been released as part of the broader ACPF related programming and can be found at: <https://acpf4watersheds.org/toolbox/finrt/>. CON-op will be officially released at a later date, as we are reframing our software to be compatible with the new ESRI Arc PRO software.

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

We anticipate the ACPF FiNRT to be integrated into mainstream approaches to conservation planning in a general sense, but also to be featured in specific watershed management plans as created by local/ regional watershed associations and partnerships. The tool is only just now being promoted and demonstrated.

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.

Products:

Bravard, E., Zimmerman, E., James, D., Tyndall, J.C. (2022). The Agricultural Conservation Planning Framework Financial and Nutrient Reduction Tool: A planning tool for cost effective conservation. *Journal of Environmental Quality*. <https://doi.org/10.1002/jeq2.20345>

Audia, E., Schulte Moore, L.A., Tyndall, J.C. (2022) [Measuring changes in financial and ecosystems service outcomes with simulated grassland restoration in a Corn Belt watershed](#). *Frontiers in Sustainable Food Systems*. Special issue: Agroecology and Ecosystem Services.

Volume 6 - 2022 | <https://doi.org/10.3389>

Critical Issue

Transformative Technology

[NC1211: Precision Management of Animals for Improved Care, Health, and Welfare of Livestock and Poultry](#)

Project Director



Body condition score accuracy and repeatability from evaluation of cull sow digital images at a midwestern harvest facility.

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

Plant-level evaluations and measurements recorded during the harvest process may represent lifetime welfare status and contribute to the economic value for each animal. Some key animal-based measures are the animal's body condition score (BCS) and skin lesions. Skin lesions can represent sources for carcass trim. Non-edible deductions or carcass trims are determined by post-mortem inspection prior to the hot boning process. These inspections can result in removing a portion of the carcass or entire carcasses condemnation due to identifying areas on the carcass that are not suitable to enter the food chain. The primary reasons for trimming swine carcasses include arthritis, abscesses, nephritis, adhesions, bruises, and contamination from foreign material within the harvest facility. Additionally, BCS may have application as an indicator trait that may be indicative for sow welfare. Sows with poor body condition represent a concern from a welfare perspective, and the resulting decreased productivity can lead to premature culling from the breeding herd and an economical loss for producers.

Modern emphasis on livestock traceability and increased demands for accountability regarding animal welfare concerns experienced throughout an animal's lifetime are leading innovation for monitoring animal welfare. As a result, remote monitoring and digital evaluation have emerged to provide increased information on these issues. Digital and infrared images have been used across multiple disciplines and species to monitor body condition, body shape, conformation, behavior, and other welfare-related traits. Infrared thermography utilizes thermal images to obtain entire body surface temperature, offering an opportunity to identify or detect possible locations for carcass trimming ante-mortem.

At the abattoir, body condition evaluation through digital image capture could be used as a cumulative indicator trait to assess the sow's lifetime welfare status. In addition, these images could be utilized as valuable feedback to producers by providing individual or group average sow body condition score after culling. Producers could use images to mitigate on-farm concerns that lead to decreased BCS or increased carcass trim. If producer conducted mitigation strategies are successful, producers may be able to increase revenue from sows at culling. While these images would add value for producers and harvest facilities, these evaluations are only useful if they are accurate, repeatable, and reproducible. These evaluations can be valuable in estimating usable product yield, as well as potential non-edible product deductions that may suggest welfare concerns, such as bruising and abscesses.

At the abattoir, body condition evaluation could be used as a cumulative indicator trait to assess the sow's lifetime welfare status. In tandem these images, both thermal and digital could allow harvest facilities to provide feedback on systemic carcass trim losses or BCS concerns, more accurately compensate producers, and ultimately purchase a more appropriate cull sow blend for making desired final processed products.

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 objectives for this study were to assess accuracy, repeatability, and reproducibility when evaluating cull-sow body condition score (BCS) using a digital medium and to determine the association and predictive capability for using infrared imaging to detect trim loss in cull sow carcasses.

Data were collected at a Midwest cull-sow abattoir. In addition to cull-sow carcass evaluations, two-dimensional Red-Green-Blue cameras collected digital images on two separate occasions and sows were selected to include the body condition variation that is typical for this particular harvest facility.

Scorer agreement within ± 1 score ranged from 88% to 97%, suggesting that scorers consistently scored body condition ± 1 score on an individual sow basis. Scoring ability was influenced by image quality and ability to evaluate the sows using digital images. It was also observed that repeatability estimates improved from round 1 and round 2, and reproducibility slightly decreased between round 1 and round 2. These repeatability and reproducibility changes demonstrate that as experience level increases, scorers may begin to develop their individual interpretation of the scale used to assess body condition. In turn, they become more individually repeatable but may differ from other scorers.

The cumulative results from the present study indicate that digital images obtained immediately prior to harvest are acceptable methods to assess cull sow BCS. The ability for scorers to accurately identify sows with a low BCS could be used by harvest facilities by providing valuable feedback on individual cull-sow and/or group average cull-sow BCS.

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

Plant-level evaluations and measurements recorded during the harvest process can play an important role in evaluating cull sow economic value and could help producers and harvest facilities to evaluate on-farm lifetime production practices. Interest in this project is based in part on the ability to obtain health-based evaluations, specifically skin lesions and body condition score (BCS), on individual sows just prior to harvest. This would allow harvest facilities to provide feedback on systemic body condition concerns or carcass trim losses, more accurately compensate producers, and ultimately purchase a more appropriate cull sow blend for making desired final processed products.

This study suggests that harvest facilities should develop protocols to identify sows that will likely yield carcasses having a great deal of trim. Live identification can serve to predict sows with large carcass trims. Live animal defect identifiers were significant contributors to percent variation. This suggests that visually identifying defects like abscesses, poor condition, mammary infection, or a combination is associated with trim loss from cull sow carcasses.

Digital imagery could play a role in providing producer and harvest facilities with feedback on cull sow conditions, areas improving cull-sow economic value, and could ultimately allow harvest facilities to purchase a more appropriate blend of cull sows needed to produce the processed meat products they manufacture. The research suggests that more evaluation is needed to determine the exact impact that these technologies may have in more accurately determining trim losses and hence the yield of edible meat products and value from cull sows

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

The Johnsonville plant where this work was conducted at has implemented the digital imagery system in their daily operations (~850 sows per day). Johnsonville is the No. 1 national sausage company, selling and serving more than 70 different varieties of sausage across 40 countries and in more than 75 U.S. professional, semi-, pro and college sports stadiums.

Agricultural machinery and technology development for advancing agricultural productivity and sustainability

Project Director

Brian Steward

Organization

Iowa State University

Accession Number

1018234



Better understanding of agricultural machinery systems for improved performance

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.

Progress has been made in incorporating knowledge of agricultural production systems into machine systems for improved performance. Specifically, new innovations in agricultural machine controls for crop production systems were patented and licensed to support the broader goals of improving resiliency and efficiency of agricultural systems. These innovations result in several direct outcomes that improve agriculture including sprayer control systems to reduce spray drift, improved adjustment of tillage depth across variable landscapes which enhances the seed bed productivity, and improvements to cotton harvest quality and efficiency. These outcomes were accomplished through basic and applied research, conducted in close collaboration between university and corporate partners and incorporating undergraduates and graduate students.

Two new laboratory facilities have been developed to improve the validity and reliability of models to provide better functional understanding of the soil-crop-machine interaction associated with agricultural machines. First, the Soil Machine Dynamics Laboratory has become fully functional to support research, extension and teaching programs including testing of new tire and

ground engaging tool technology and tours to visitors from private industry and crop growers. Research output generated from work leading to improved understanding of the effects of soil-to-machine systems on soil compaction, and traction were published in journal articles and presented at conferences.

Secondly, the Off-highway Vehicle Chassis Dynamometer Laboratory was opened in 2023. Testing of full vehicle traction systems was initiated with the goal of improving vehicle drive train performance and efficiency. Vehicle emissions equipment to enable the testing of full vehicles to investigate the effect of vehicle powertrain controls on emissions levels was purchased. Delivery of this equipment was delayed due to supply chain issues, but arrived late in the year and is being installed. This lab will enable investigations of full vehicle power systems seeking to improve the delivery of power to agricultural production systems.

A comprehensive multibody dynamics model of a self-propelled sprayer was developed in which the majority of the mechanical, hydraulic, and control subsystems were accurately represented in a virtual environment. This aggregate model was leveraged for a wide variety of activities including functionally understanding dynamic interactions between different mechanical subsystems and how those interactions affect overall machine stability, boom height control development and testing, and experimental control system development. During the validation phase of this self-propelled sprayer model, fundamental validation principles and data analysis methods needed to properly validate full-vehicle models of this scale were established. These principles will help streamline the creation and validation activities of future similar models, which will help build further accuracy and confidence in the utilization of these types of models across the machine systems community.

There was also progress in the development of new methods of sensing and data analytics in complex mechanical, fluid, and biological systems which serve as enabling technologies for scientific research and automation systems.

During this reporting period, robotic solutions for field-based plant phenotyping were developed to meet our goal of developing new methods of sensing and data analytics to advance scientific research and automation systems. Specifically, PhenoBot 3.0 navigation control was improved when a 10-ft-tall GPS antenna mast was employed to traverse through crop rows of fully grown maize plants. The 3D stereo vision module, PhenoStereo, was redesigned to improve its reliability and strobe light power. A preliminary algorithm was built for maize plant leave area sensing and soybean plant seed pod characterization. A large amount of 3D point cloud data for maize plant leaf angle measurements for genetic dissection of the leaf angle control mechanism were collected. Algorithms for sweet potato harvest loss characterization were improved by using UAV captured multispectral aerial images via deep learning approaches.

An integrated cyber-enabled environment was developed that integrates Lidar sensing data with advanced data analytics and modeling tools to advance the planning, implementation and adoption of precision conservation management at the field and landscape levels.

New sensing and control automation methods were developed to improve chassis suspension dynamics and stability for self-propelled sprayers and tractor applications. These projects are working with state-of-the-art model-based software techniques to intelligently control active mechanical and hydraulic components integrated within chassis suspension system architectures.

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

Five specific audiences were benefited by the results of this project. These audiences included:

1. Agricultural Producers: Results from relevant research were disseminated directly to agricultural producers through active engagement with state and national extension programming efforts.
2. University Students: Results were integrated into academic coursework at Iowa State University and knowledge generated was transferred to students in relevant courses.
3. Academic and Scientific Community: Peer-reviewed results were disseminated through leading academic journals to enhance the knowledge base within the agricultural engineering scientific community.
4. Agricultural machinery Industry: Results were shared with peers in the agricultural engineering and agricultural machinery industry. These results created 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 were shared with scientists in agricultural genetics companies as well as developed technology was adopted for the development of plant traits.

Briefly describe how the broader public 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 2022 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 crop production in Iowa.
- Provide 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 ten hours 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.

On research disseminated in relation to soil compaction and tillage for precision agriculture management, extension reports and presentations were delivered on time and focused to growers and extension experts for minimizing soil compaction from modern heavy equipment operating in wet soil conditions.

The success of PhenoBot 3.0 development provides an automated solution for field-based phenotyping of row crops, particularly those tall-growing crops like maize and sorghum which are substantially more difficult to phenotype under field conditions. PhenoBot 3.0 has been successfully utilized by plant scientists and provided them with a unique and enabling tool to conduct some large-scale field-based plant genomics research projects. This research project has generated outstanding opportunities for students from disciplines of engineering, computer science, and agronomy to learn to work in teams and engage in the state-of-the-art interdisciplinary research. This robotic technology has been demonstrated to a broad range of audience including the National Corn Grower Association (NCGA) Board, a delegation of the National Association of Plant Breeders (NAPB), Iowa Soybean Association, and a group of Iowa Legislators, raising the public awareness and administrative support to the advancement of engineering technologies for the new discoveries in plant sciences.

Precision conservation is a farmer/producer-driven landscape management that is known to redefine how landscape conservation is approached. Implementing precision conservation practices helps farmers to not only maximize productivity and environmental benefits but also minimize economic investments.

An efficient and sustainable agricultural system, integrating precision conservation and associated practices, limits nutrient and sediment runoff, protects water quality, sustains rural community economies, and contributes to food security. AGCONDST, developed as part of this project enhances the capability and success of producers and resource managers in improving soil and water quality while increasing return on investment.

By improving the fundamental dynamic behavior and stability of the chassis suspension and therefore the cab structure of these agricultural machines, operators will be more comfortable throughout the day, which will allow them to operate these machines more effectively, precisely, and at increased machine capacity rates. Given that operators will be able to run machines more hours in a given day because of lower fatigue levels, this will enable higher machinery operation efficiencies, especially when operating these machines in sometimes narrow agricultural production system seasons.

National Animal Genome Research Program

Project Director

Christopher Tuggle

Organization

Iowa State University

Accession Number

1018103



Progress in genetic and functional genome analysis in swine and cattle

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

1. Functional analysis of the swine and cattle genomes

ISSUE: 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 and is used to identify genetic variation associated with economic traits. However, we lack the knowledge of the functional components of food animal genomes. The constant advancement of genetic technology has produced new opportunities for such functional analyses. In this report, we explain new results that advance our technologies to interpret genomic information in both pigs and cattle.

2. Genetic improvement of disease resilience in pigs

ISSUE: Disease resilience, which is the ability of an animal to recover from disease maintain productivity, is in part determined by genetics but is difficult to select for because breeding populations must be kept free of disease. Our goal in this project is to develop so-called indicator traits that can be measured on young healthy pigs and are predictive of resilience.

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.

Swine

We have developed new genomic information that will help the functional annotation project (FAANG) funded by the USDA-NIFA. In one project, we sequenced the genome of the two Yorkshire pigs whose tissues were collected for a number of assays that measure the nature and structure of the chromatin (DNA-protein complexes that make up chromosomes). Analyzing all the data from these assays across many tissues will lead to the mapping of functional parts of the pig genome. These assays produce sequence data which must be aligned to the genome; the reference assembly (Ssc 11.1) we currently use is from a Duroc pig. Since there may be genetic differences between our sequence data and that of the reference Duroc, we developed genome assemblies of the individuals whose tissues and cells are being used for the FAANG project, to compare these assemblies to the 11.1 assembly. Genomic DNA for pigs 348 and 350, currently used for all adult tissue-based assays, was sequenced using Nanopore technology. The pig 348 and 350 genomes are excellent quality, with more than 90% of the sequence in sub-assemblies >60 Million base pairs in length. In fact, most chromosomes are covered by a single set of overlapping sequences; we also showed that assembly completeness was high, as 96% and 95%, respectively, coverage of a set of widely used reference genes across species. This result compares well to the current 11.1 reference assembly (96%). Further analysis of pig 348 and 350 assemblies will include comparison of mapping rate of epigenetics data to the 11.1 reference assembly.

In another project, we have used new technology to sequence the RNA in individual cells that are circulating on blood or present in immune tissue such as thymus, spleen, bone marrow and lymph nodes. We have analyzed these data and have found that cells clustered by their similarity of gene expression patterns form from 18 separate clusters in spleen to up to 44 clusters in bone marrow. Using this cluster information, we can predict the transcripts that identify specific cell types that perform different functions in an immune response. These data will also allow us to estimate the unknown cellular composition of other blood samples. Once the composition of a whole blood sample is estimated, a researcher can then predict which variants are controlling gene expression in a specific cell type.

In the natural disease challenge projects, several immunological and haematological assays were measured in blood of young healthy pigs prior to their entry in a natural polymicrobial disease challenge, including complete blood counts, natural antibodies, mitogen stimulated proliferation of peripheral blood mononuclear cells, antibody- and cell-mediated immune responses, and phagocytosis and immune stimulation assays. Several of these measures were estimated to have substantial heritability and sizeable genetic correlations with traits related to disease resilience that were measured on these same pigs in the natural disease challenge. In addition, several high-throughput molecular profiling technologies were applied to blood samples collected on these pigs prior to their entry into the natural disease challenge, including transcriptomics, proteomics, and metabolomics. Because of limited statistical power, these studies did not identify clear signals for individual features (i.e., the expression of a single gene or the abundance of a single protein or metabolite) that were both heritable and genetically correlated with resilience. However, when combining results across genes using enrichment analyses, there was evidence that the expression levels of genes that were involved in immune response were genetically correlated with disease resilience traits. Similar results were obtained for protein levels.

Cattle

In one project a multi-omics approach was used to combine transcriptome and epigenetic data to identify 171,985 unique transcripts, including 35,150 unique genes, 159,033 transcripts which were validated by multiple independent long-range sequencing, annotation and other functional genomics datasets. Many of these transcripts (69%) were novel, which resulted in double the number of current annotations per gene provided by Ensembl and NCBI. Approximately 50% of the protein-coding genes were transcribed as both coding and noncoding transcripts. This new annotation of the bovine genome extended the boundaries of more than 11,000 known genes compared to Ensembl or NCBI annotations. These validated results show significant improvement over current bovine gene and transcript annotations.

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

Swine

This project has created new assemblies that will allow the researchers in FAANG to better analyze their data to determine the function of each part of the genome. We also produced new information on the gene expression patterns in specific cells in a number of tissues and blood. This information can be used by at universities and breeding companies to analyze their animal's genome and predict function, and accelerate genetic improvement.

Through publications and presentations, we have 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 gene expression data mapped to specific cells to filter variants associated with important traits and accelerate genetic improvement.

The natural disease challenge project has been conducted in close collaboration with seven international swine breeding companies and on pigs from their commercial lines. This close industry collaboration has enabled a broad sector of the swine breeding industry to directly benefit from this work and provide information on their commercial lines. The rest of the swine breeding industry benefits from this work because all results are published in scientific journals and presented at scientific and industry conferences. Swine producers benefit from the genetic improvement for disease resilience that is made as a result of this research.

Bovine

This project has created new annotations of bovine genes and transcripts to help determine functional regions of the bovine genome. This research provides needed information about the function of previously unannotated regions of the bovine genome that may help in the identification of DNA variants that link genotype to phenotype.

One manuscript was submitted on this research and all data associated with this manuscript have been submitted to the European Nucleotide Archive public database to allow other researchers to use these data to further their own studies. We have also provided access to the preprint of this manuscript at bioRxiv (<https://www.biorxiv.org/content/10.1101/2022.10.05.510963v1>) and are working to make the transcriptome and other resources generated by this study available to anyone in the community for their use. These data have been integrated with the animal QTL database and a gene-trait network generated from these data are also publicly available: <https://www.animalgenome.org/host/reecylab/a>.

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 several 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.

A specific example for this report would be that researchers can use our new FAANG-resource assembly to improve the use of FAANG data to predict functional components of the pig genome, and potentially improve breeding decisions based on this information.

Second, the general public and society will benefit from genetic improvement of pigs for disease resilience because it is expected to reduce cost of production, which will eventually translate into lower consumer prices for pork, as well as improved animal welfare. In addition, the reduced veterinary treatment that more resilient pigs are expected to require, will reduce the use of antibiotics and the associated risk of development of antibiotic-resistance of pathogens.

Overall, the public has access to all of the publications from each objective, providing visibility and transparency to our results and activities. We also publish meeting minutes for the FAANG Steering Committee and other Task Forces in which we participate, as well as 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.

Results were disseminated to multiple communities in several ways. First, because of the cancellation of the PAG meeting in January 2022, we held a virtual Swine Genome Workshop on-line February 3, 2022. Fifteen presentations were made, including 12 scientific presentations (including talks by 4 students, 2 postdoctoral students, and six faculty) and 3 talks (including comments from an industry representative, the NIFA representative and the Swine Genome Coordinators). 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 2500 scientists in over 50 countries, usually 1-3 times a week. Finally, both Pig Genome and Bioinformatics Coordinator reports are given orally each year at the NRSP8 Workshop in San Diego during the Plant and Animal Genome Conference.

Overall, professional development was provided to several graduate students, where they orally presented their genomics and/or bioinformatics research to gain experience as a speaker. Specifically, three students further received support to travel to the Plant and Animal Genome Meeting from NRSP8 funds; in 2022 PAG was cancelled and funds were either deferred to 2023 or used by students to report results at other meetings. We also trained researchers to use genomic and high-throughput molecular data.

The pig resilience project has provided opportunities for 1 MSc and 5 PhD students, of which 2 PhD students still in the program, as well as 2 post-doctoral fellows, of which one is still working on the project. These student and post-doctoral fellows have made a total of 17 poster or oral presentations at scientific meetings and, to date, published 10 papers in scientific journals as first authors, with several additional papers in review or preparation.

The porcine and bovine FAANG projects provided professional development for 2 graduate students and 2 post-doctoral fellows during 2022, who will present research findings in 2023 at the Plant and Animal Genome conference on new research in the integration and sharing of swine/bovine FAANG data through EpiDB.

Not Provided