Illinois (University of Illinois) Annual Report - FY2021

Report Status: Approved as of 07/22/2022

Contributing Organizations

University of Illinois

Executive Summary

Overview

The College of Agricultural, Consumer and Environmental Sciences

The College of Agricultural, Consumer and Environmental Sciences (ACES) at the University of Illinois at Urbana-Champaign strives to discover, advance, and integrate new knowledge to ensure nutritious and safe food, sustainable and innovative agriculture, strong and economically resilient families and communities, and environmentally sustainable use of natural resources to benefit the people of Illinois and the world. The College of ACES conducts world-class educational and research projects that play key roles in national and international research initiatives in biological, physical, social, and economic sciences. The scope of the college has broadened dramatically since its founding in 1867, while its purpose remains focused on advancing scientific knowledge that makes life better, healthier, safer, and more profitable for people in Illinois and around the world. ACES research and education centers, located throughout the state, provide a vital testing ground where research can generate practical applications that benefit consumers, farmers, commodity groups, agricultural organizations, environmentalists, conservationists, government agencies, industry, and business.

Accordingly, the 2020-2025 ACES Strategic Plan (https://aces.illinois.edu/strategic-plan) aligns with the campus strategic plan and the college's guiding principles to address grand challenges related to food and agriculture, families and communities, and the environment. In Fall 2020, each academic unit within ACES completed action plans designed that collectively intent to:

- Foster scholarship, discovery, and innovation
- Provide transformative learning experiences
- Make a significant and visible societal impact
- Steward current resources and generate additional resources for strategic investment

ACES is an interdisciplinary community of scholars and learners, spanning life sciences, social sciences, and engineering, committed to addressing societal challenges related to food, agriculture, environmental sustainability, and human well-being. ACES has a workforce of more than 1,400 people including 182 full-time tenure system faculty, 63 full-time specialized faculty, and 658 Extension employees. The ACES student body consists of 2,820 undergraduate students and 756 graduate students.

University of Illinois Extension

Extension is a centrally budgeted unit, which resides in ACES and reports to the Dean. Federal, state, and county resources support Extension's mandate to serve residents of Illinois in every county. As part of its more than $58M annual budget, Extension received over $10M in federal Smith-Lever funds to conduct agricultural extension work in 2021. This federal investment requires one-to-one state or local matching contributions.

Several changes occurred to Illinois Extension's programmatic infrastructure in 2021. Extension launched a new program area, Integrated Health Disparities, which strategically expands outreach to vulnerable populations. After significant input from stakeholders, the Agriculture and Natural Resources program area transitioned into two separate program areas: 1) Agriculture and Agribusiness and 2) Natural Resources, Environment, and Energy. Each new program area has a dedicated state program leader to provide programmatic oversight and expertise.

To address anticipated pandemic-related budget shortfalls, the University of Illinois at Urbana-Champaign offered a financial incentive to staff eligible for retirement in 2021. Four of the five Extension field operations administrators elected to retire during the summer of 2021, including the Associate Director of Field Operations and all three Regional Directors; this created vacancies in key Extension leadership roles. This unprecedented situation presented an opportunity for Extension leadership to pause and engage Extension staff in discussions to explore how changes to administrative structures, roles, and support could increase organizational effectiveness and capacity. Extension's Director, Dr. Shelly Nickols-Richardson, will announce any changes to the administrative organizational structure in FY 2022.

The Office of Research – The Illinois Agricultural Experiment Station

The Illinois Agricultural Experiment Station (IAES) is a subsidiary unit of ACES managed in the Office of Research with a statutory federal mission to conduct original research, investigation, and experiments which contribute to the establishment and maintenance of the agricultural industry in the United States. The IAES is a federal-state research partnership funded through the Hatch Act of 1887, which requires a one-to-one matching state investment. The IAES also participates in the Animal Health and Disease capacity program, collaborating with the College of Veterinary Medicine.

Hatch-funded activities at Illinois encompass research on all aspects of agriculture, including:

- Soil and water conservation and use
- Plant and animal production, protection, and health
- Processing, distribution, safety, marketing, and utilization of food and agricultural products
- Forestry, including range management and range products, multiple use of forest rangelands, and urban forestry
- Aquaculture
- Family and consumer sciences
- Food sciences and human nutrition
- Rural and community development
- Sustainable agriculture
- Molecular biology
- Biotechnology

Hatch-Multistate funding supports cooperative research employing multidisciplinary approaches. The IAES collaborates with other state agricultural experiment stations, the USDA Agricultural Research Service, and other colleges and universities to solve problems that concern more than one state. McIntire-Stennis funds are allocated directly for forestry research.

College of ACES Budgeting

The College of ACES has a budget of more than $118M. Over the past two budget cycles, ACES has diligently worked to reduce dependence on state funding and to internally adjust to a new university budget model (Integrated and Value-Centered Budgeting (IVCB)). As part of the change in campus budget practices, the College of ACES is absorbing a scheduled reduction in centrally allocated finance by generating increased tuition revenue and other funding streams. Additionally, the college has implemented budget management strategies to generate more sustainable funding platforms for research, teaching, and Extension activities through improved return on state-funded investments and expanding nonstate funding streams.

Changes in the College of ACES

In August of 2021, Dean Kimberlee Kidwell was named Associate Chancellor for Strategic Partnerships and Initiatives for the University of Illinois. Dr. Germán Bollero is currently serving as Interim Dean, Associate Dean of Research, and Director of the Illinois Agricultural Experiment Station. Dr. Alex Winter-Nelson, Associate Dean of International Programs, is currently serving as Acting Associate Dean of Research and Acting Director of the Illinois Agricultural Experiment Station. Dr. Mary Arends-Kuenning, Associate Professor of Agricultural and Consumer Economics, is currently serving as Acting Associate Dean for International Programs.

Critical Issue: Community Involvement, Inclusion, and Leadership

Hatch and Multistate Hatch funds supported research under the Community Involvement, Inclusion and Leadership Critical Issue, including:

- Youth and emerging adult leadership education to illustrate how this population understands the concept of leadership in general and their own practices in particular
- The recent recession effects on children's cognitive, socioemotional, behavioral, and physical health over time within the context of their families, schools, and communities
- The impact of energy infrastructure development on rural farms

- Improving the ability of judicial courts to properly consider safety issues related to intimate partner violence, particularly among divorcing parents involved in custody and visitation disputes

Through these projects and others, ACES has used Hatch and Multistate Hatch funds to research community involvement, inclusion, and leadership.

In 2021, Extension provided 791 educational sessions, including 445 online learning opportunities. More than 22,000 participants attended sessions aimed at supporting thriving youth, connectedness and inclusion, and leadership development. In addition, more than 19,500 4-H club affiliations provided opportunities for positive youth development with the support of 2,636 adult club volunteers across the state. Extension educators and program coordinators provided training and support to more than 6,445 volunteers who connect with residents in their communities through the signature **Master Gardener**, **Master Naturalist**, **Money Mentor**, and **4-H** programs. Collectively, volunteers devoted nearly 490,000 hours in service to their communities, which is valued at more than $14M.

Illinois Extension collaborated on a variety of multistate Extension activities in 2021 to support thriving youth, families and communities. Extension educators collaborated with 4-H staff from around the country in the **National Association of Extension 4-H Youth Development DEI Working Group** to advance diversity, equity, inclusion, and access (DEIA) in 4-H and through the **True Leaders in Equity Institute**. Educators also collaborated with Extension colleagues from nine states on the **Thriving Youth Champion Workgroup** to promote implementation and education of the 4-H Youth Thrive Model**.** As part of this work, educators interviewed 4-H members from multiple states and coded qualitative results to examine the impact of the COVID-19 pandemic on the ability of youth to thrive. In another multistate collaboration called **Pulaski Proud**, online meetings provided a platform for 4-H youth to compare and contrast their experience of living in Pulaski County across multiple states, which created connections and fostered learning. Currently, a new multistate opportunity is underway to pilot and evaluate a curriculum to foster civic engagement in middle school and high school students. The North Central 4-H Program Leaders met monthly to collaborate around shared mission mandates, including institutional and programmatic innovation as a response to COVID-19 as well as strategies for advancing our collective DEIA mission.

Through other multistate efforts, Illinois Extension worked with colleagues from Purdue Extension and The Ohio State University to develop and pilot test a model for **Recovery Oriented Systems of Care** (ROSC) that uses a complex adaptive system to solicit, organize, manage, and evaluate community responses to substance use disorder. Another collaboration with Purdue Extension and Iowa State Extension focused on developing the **Extension Community Development Library**, an online platform for Extension professionals seeking community development programs and resources.

Critical Issue: Economic and Workforce Development

Hatch and Multistate Hatch supported research under the Economic and Workforce Development Critical Issue, including:

- Analyzing the local, state, federal and international laws that significantly impact agriculture and natural resources
- Working to understand farmer adoption behavior for genetic technology and the impact that providing information has had on dairy sector productivity growth
- Analyzing price dynamics in agricultural commodity markets with specific emphasis on corn, soybeans, and other field crops important to the U.S. Midwest
- Assessing the value of USDA reports in the electronic era by identifying the efficient price return variance of corn and soybean futures prices following the report release
- Measuring the impact on economic and environmental outcomes of new technologies in the food and agricultural system (such as applications of modern data sciences towards nitrogen management, water management, climate resilience, and post-farm logistics)
- Determining how, theoretically and empirically, information produced by and the actions of governments in commodity-producing countries can impact market volatility

Hatch projects integrated with Extension included:

- Surveying Illinois farmers to identify the prevalence of major stressors (financial, economic, environmental, and interpersonal)
- Assessing the prevalence of mental health conditions
- Assessing the prevalence of physical and mental health conditions and agricultural injury

Extension focused on key contributors to a strong economy, including increased economic vitality within Illinois communities, increased workforce preparedness and advancement, and improved financial wellbeing among Illinois residents of all ages. Collectively, Extension offered more than 3,000 educational sessions attended by more than 151,000 participants to address economic vitality, promote workforce development, and support financial wellbeing. With Internet connectivity as a continued priority, Extension offered free Wi-fi

access from the parking lots of some of its 115 Illinois offices as part of the **American Connection Project**. Extension's partnership with the **Jackie Joyner-Kersee Center** in East Saint Louis expanded through a new collaboration with the **Donald Danforth Plant Science Center**. This powerful partnership will create a hands-on STEM education and work force development pipeline from kindergarten through adulthood that provides opportunities for people to develop marketable skills in urban agriculture, innovation, and entrepreneurship while learning about the importance of food production and improving their own communities' access to nutrition. The East Saint Louis 2020 unemployment rate of 10.4% far exceeded the state unemployment rate of 6.5%, which demonstrates a critical need for this partnership.

Disaster preparedness is essential for mitigating impacts on community vitality and the economy. Extension collaborated in multistate program development and training to activate a volunteer reception center in the event of a disaster; to educate livestock producers, specialty and row crop farmers, and ranchers on the importance of disaster preparedness in all facets of their operation; and to design **AgReady**, an adaptation of the Ready Business curriculum. Extension field staff played a leadership role in facilitating multistate associations focused on disaster preparedness. One educator chaired the **Extension Disaster Education Network** (EDEN) and the EDEN national conference. An Extension county director chaired the **Disaster Ready Quad Cities** coalition that focuses on volunteer management, donations management, and long-term disaster recovery efforts influencing four counties on the Illinois-Iowa border.

Other multistate collaborations support economic vitality for rural communities and agricultural operations. The **Midwestern Hemp Database**, administered by an Illinois Extension commercial agriculture educator, leverages grower-collaborator networks and university research stations to provide research-backed regional insight into agronomic performance and cannabinoid development of industrial hemp varieties. **Celebrating REtail, Accommodations, Tourism and Entertainment by Building Rural Innovations and Developing Growth Economies** (**CREATE BRIDGES**) is a multistate extension project, piloted in 2021, that supports retail and hospitality sector businesses and their workforce in rural regions of Illinois and partner states.

Critical Issue: Safe, Healthy Environments and Behaviors

Hatch and Multistate Hatch supported research under the Safe, Healthy Environments and Behaviors Critical Issue, including research on:

- Mechanisms regulating human fat sensory perception and their role in the physiological processes that regulate fat metabolism
- Policies, systems, and environmental factors that influence the consumption and waste behaviors of children and their families, particularly in a school setting
- Impacts of obesity on nutritional status during and following pregnancy among rural populations of women participating in the Women, Infants, and Children program
- How early nutrition affects the interactions between microbiome development, growth trajectories, and risk of childhood obesity
- Impact of environmental estrogens on cardiovascular disease and metabolic health of women in Illinois
- How parental leave affects different outcomes in families and at work and the identification of policies that will benefit children, parents, and the economy as a whole
- Safety of botanical estrogenic dietary supplements on breast cancer metastasis

Hatch projects integrated with Extension included work to determine the intention and actual use of diabetes-related apps by diabetes clinicians and health care administrators; continuation of the Community Participation and Genomic Integration for Health (CPgI4H) project that provides a unique research opportunity as studies addressing gene-environment interactions in the pathogenesis of obesity or weight gain trajectories are lacking; programming that targets tobacco use (the leading preventable cause of death in the United States with enormous costs to individuals, their families, and our communities); and a project to investigate the effect of thermally abused frying oil on subsequent metastasis from bone to visceral tissues (there has been considerable breast cancer research related to treatment, however a less-investigated area that is critically important is metastasis - especially late-stage when there is metastasis to the bone).

In 2021, nearly 190,000 participants attended 10,274 educational sessions; 60% of these sessions were delivered by Extension through live or asynchronous (structured and self-directed) online formats to promote healthy behaviors and make health-positive changes to the environments people live, learn, play, and grow. Extension's collective **Illinois Nutrition Education Programs** (INEP), comprised of the **SNAP-Ed** and **EFNEP** programs, targeted geographical areas throughout Illinois where vulnerable populations are highest. Direct education targeted populations most vulnerable to chronic diseases highly correlated with behavioral choices around nutrition and physical activity. In 2021, more than 1,200 community partnerships were developed or nurtured with K-12 schools, early childhood centers, community-based agencies and centers, and emergency food sites to extend resources and maximize opportunities to support healthy behavioral choices and environments. Target audiences of Extension's core programs to support physical health and mental health included youth (e.g., **4-H Health Rocks**, **4-H Your Thoughts Matter**, **4-H Cooking 101**) and professionals who engage with youth to

employ practices that create safe environments (e.g., **Trauma Informed Classrooms, Youth Mental Health First Aid**). Other audiences include farmers and farm families (**Farm Mental Health, AgrAbility**), caregivers, veterans, and individuals looking for reliable and objective sources to inform decisions about their health.

Extension launched a new multi-disciplinary initiative in 2021: **Health Equity Achieved Together Project**. This project promotes collaboration between **Illinois SNAP-Ed** and other programs within Extension through funding to develop and implement innovative strategies to improve health outcomes and reduce community barriers to adopting healthier lifestyles. A key component is engaging with local stakeholders and community members to inform design and implementation of the local efforts.

Illinois Extension Family and Consumer Sciences educators served as members of multistate and national groups such as the **National Extension Association of Family and Consumer Sciences Awards Training Subcommittee**, **Be Healthy Quad Cities Coalition**, **All Our Kids Network**, and the **Food Rescue Partnership**. One educator, serving as Co-Primary Investigator on a **Walmart Healthy Habits Grant**, participated in meetings with colleagues in the North Central Region to discuss implementation and delivery methods associated with the grant. A team of educators completed the Ohio State University-led **Trauma Informed 101** train-the-trainer course and subsequently offered the program to Illinois Extension educators to build organizational capacity around creating trauma-informed educational experiences.

Critical Issue: Safe, Plentiful, and Accessible Food Supply

Hatch and Multistate Hatch supported research under the Safe, Plentiful and Accessible Food Supply Critical Issue, including:

- Determination of photosynthetic productivity of different commercial corn and soybean varieties on a whole-plant basis in response to differing levels of management inputs
- Generation of geospatial datasets and analytical methodologies to improve our understanding of the nitrogen cycle in corn-based cropping systems
- Development of new, high-yielding soybean varieties for farmers that will help increase profitability
- Implementation of a redesigned wheat breeding strategy to achieve faster rates of genetic improvement for economically important traits
- Improvement of farm management based on practical livestock care decisions as well as utilization of digital technology to improve efficiencies in livestock systems
- Contributions to potential development of a vaccine for cryptosporidium parvum
- Improving the safety of Hispanic-style fresh cheeses.

Hatch and Multistate Hatch supported research under the Safe, Plentiful and Accessible Food Supply Planned Program also focused on:

- Characterization of the mechanisms regulating skeletal muscle growth in livestock to increase rate and efficiency of muscle growth
- Development of user-friendly new technologies (e.g.. smart packaging) for monitoring the quality and safety of food products and for inactivating pathogens to reduce food waste and increase food safety
- Translation of state-of-the-art quantitative genetics approaches to result in real, tangible benefits to crops grown in Illinois
- Improving treatment of bacterial spot diseases caused by *Xanthomonas* species that negatively impact production of vegetable crops (suc as tomato, pepper, pumpkin, and squash)

Hatch projects integrated with Extension included research focusing on:

- Yield loss caused by plant-parasitic nematodes on economically important crops
- Soil copper and lead accumulation and impacts on microorganisms relevant to profitable and safe vegetable production
- Nitrogen cycling and management in perennial cropping systems
- Herbicide resistance mechanisms not caused by changes in the herbicide target site
- Corn rootworm control methods and improved decision-making procedures for rootworm management
- Effective management of bitter rot disease of apple
- Consumers' choices and behaviors regarding fruits and vegetables
- Small-scale and very small-scale farmers and growers use of water for agricultural operations
- Bats with the goal of controlling crop pests, which has important implications for ecosystem health and the economics of large-scale production agriculture

With an overarching goal of maintaining a safe and accessible food supply, Extension outreach aimed to improve the quality and quality of food sources and products, increase food safety, and decrease food insecurity. In 2021, nearly 57,000 participants attended more than 1,300 educational program sessions to address this critical issue. Agriculture and Natural Resources (ANR) educators responded to

5,800 inquiries to support crop and livestock producers who are essential contributors to the food supply. Several conferences and institutes converted from in-person to online live and asynchronous formats including **CropFlix** (historically the annual Crop Management Conference), the **Illinois Specialty Crop Conference**, and the **Southern Illinois Fruit and Vegetable School**. Extension-supported volunteers managed 123 active food donation gardens throughout the state that generated nearly 168,000 pounds of donated produce valued at nearly $242,000. **SNAP-Ed** educators helped emergency food site personnel take action to remove barriers to healthy food selection among vulnerable populations. A variety of food safety courses provided food producers, food managers, Cottage Food operators, food handlers, and gardeners with safe ways to harvest, handle, and store food products.

Multistate Extension activities in 2021 included jointly planned conferences and delivered conference sessions. Audiences from multiple states attended the **Bi-State Crops Conference**, the **Bi-State Garden Conference**, the **Bi-State Small Farms Conference**, the **Driftless Region Beef Conference,** and the **Four-State Dairy Nutrition and Management Conference**. In addition, Extension educators joined colleagues from other states to serve on relevant networks, committees, and associations. These efforts included: the **Partnership for Food Safety Education**, the **National Extension Association of Family and Consumer Science National Mentoring and Leadership Committee**, the **North Central Food Safety Extension Network**, **Tri-State Extension Networking**, the **Organic Agronomy Training Service Midwest Advisory Committee**, and the **Midwest Cover Crops Council**. Extension educators and University of Illinois researchers participated on a University of Maryland-led multi-institutional team to establish a **Dashboard for Agricultural Water Use and Nutrient Management** (DAWN).

Critical Issue: Thriving Natural Resources

Hatch and Multistate Hatch supported research under the Thriving Natural Resources Critical Issue through projects that focused on:

- Individual and interactive ecological effects of climate change, land use practices, stakeholder use, and invasive species on fish communities and aquatic ecosystems
- Understanding how birds' use of habitat affects population dynamics in order to inform how natural resource managers effectively manage habitats
- The utilization and integration of modern analytical instruments and techniques to provide information on physical properties, chemical processes, and biological processes occurring in soil systems
- Improvements in the design of ground source heat pumps
- An investigation into plant pigments in wild, weedy, and cultivated amaranth species to improve our understanding of agronomic, adaptive, and nutritional traits within the genus
- An investigation into how agricultural management and environmental parameters affect emissions of the greenhouse gas nitrous oxide
- An evaluation of land-use and cropping systems on water availability and water quality and determination of alternative crop and water resource management practices
- Work addressing the effects of biochar use in animal mortality management
- The identification of genetic regulators in maize with the goal of optimizing maize plants for greater yield and resource use efficiency
- Continuation of the Program in Ecology, Evolution and Conservation Biology (PEEC supports students conducting research in ecosystem health and restoration, conservation biology, biodiversity in agricultural and natural landscapes, agriculture and land-use change, and anthropogenic effects on ecosystems)
- The development of small, smart soil sensors that can be mounted on existing equipment

Hatch projects integrated with Extension included work to refine and improve the practice of denitrifying bioreactors to mitigate agricultural drainage nitrogen losses for societally-desired clean water outcomes, the use of wireless transmission for simultaneous measurement of salient features of soil properties and processes through the propagation path, the conducting of trials to develop valuable information to golf course superintendents and other turf managers for managing dollar spot, and a project that demonstrates the potential adaptation of high yielding perennial energy crops with comparable economic benefits and environmental services.

Overall, Extension hosted more than 1,800 educational sessions (attended by more than 86,000 participants) to improve engagement with home and community landscapes and to enhance or sustain natural resources. More than 50% of educational sessions were offered online or through asynchronous methods. Extension's Agriculture and Natural Resource (ANR) teams delivered 262 statewide webinar sessions and posted 282 new videos to Extension's` website, which leveraged a statewide network of experts and increased access to environmentally focused programming across the state regardless of local expertise. ANR teams responded to 5,400 inquiries for on-demand expert consultation to meet the needs of residents for customized information to support decision-making. Despite challenges associated with ever-changing COVID-19 pandemic restrictions and guidance in 2021, Extension supported core and continuing education training for 3,720 active **Master Gardener** and **Master Naturalist** volunteers. These volunteers donated more than 232,000 hours of service

to their communities and responded to more than 83,000 inquiries for assistance from residents with horticulture needs. Master Gardener volunteers supported 278 community gardens throughout the state, which provided a venue for experiential learning, therapeutic opportunities, and local food production.

Several multistate Extension activities addressing the environment focused on continued collaborations from prior reporting years. Extension participates in the **North Central ANR Program Leaders** group through monthly meetings and an annual retreat to share programming resources. Extension also participates in the **Illinois-Indiana Bi-State Ag Group**, a team of Illinois and Indiana Extension educators that plans three to five joint programs annually. Additionally, Extension serves on a North Central Region committee discussing climate change programming. An Illinois Extension commercial agriculture educator serves as the North Central Region Director for the **National Association for County Ag Agents**. Other educators collaborated with colleagues from other land-grant institutions to design a **Master Watershed Steward** training curriculum for Master Naturalist volunteer continuing education and to provide **Gardening in the Air**, a virtual half-day event focused on an ala carte menu of nine gardening, environmental, and nature-related sessions. This bi-state virtual learning opportunity provided an alternative to the in-person gardening days not feasible in 2021 due to the pandemic. The successful inaugural program sparked plans to offer as a semi-annual event in the future.

Merit and Scientific Peer Review Processes

Updates

None.

Stakeholder Input

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

The College's leadership interacts frequently and significantly with internal university organizations and external stakeholders who represent themselves or larger organizations. In general, external stakeholders include individual agricultural producers, agricultural commodity organizations, state and federal legislators and agencies, academic and corporate partners, and international partners.

In FFY 2021, the Associate Dean for Research/Director of the Illinois Agricultural Experiment Station interacted with stakeholders as noted below:

1. Service on the Board of the Illinois Nutrient Research and Education Council
2. Meeting virtually or in-person on multiple occasions with leadership and members of the Illinois Farm Bureau, Illinois Corn Marketing Board, Illinois Corn Growers Association, Illinois Soybean Association, Pork Producers, Illinois Beef, and other organizations
3. Collaborative activities with corporate partners including Bayer, Syngenta, Wyffels Seeds, GDM, Burrus, ADM, Tate and Lyle, Growmark, Agrible, and Kraft Heinz
4. Service as a member of the joint steering committee of the University of Illinois/Corteva partnership to coordinate collaborative efforts in research, education, and outreach between the two organizations
5. Participation in the meeting of the Illinois Agricultural Legislative Roundtable in January 2021 (virtual meeting that included IFB, multiple commodity organizations, and other educational institutions in Illinois that have agricultural programs)
6. Working with representatives of the Illinois Corn Growers Association on development of an internal seed grant program associated with an award from the Regional Conservation Partnership Program
7. Participating in virtual meetings of the Illinois-Indiana Sea Grant advisory committee
8. Virtual meeting with members of the Illinois House Delegation or their staff to discuss issues of importance in agricultural research
9. Virtual meetings of the North Central Region AES directors in March of 2021
10. Virtual meeting with External Advisory Committee of the Division of Nutritional Sciences in the College of ACES
11. Participating as a member of the advisory committee for the UIUC Institute for Sustainability, Energy, and Environment

Beyond these engagements of the Director of the Illinois Agricultural Experiment Station, each department in the College of ACES has external advisory committee members representing the private sector, governmental agencies, and not-for-profit organizations. These individuals are invited to virtual and on-campus sessions.

Methods to identify individuals and groups and brief explanation

The COVID-19 pandemic dramatically increased reliance on online communication, which increased proficiency with virtual meeting tools such as Skype, Zoom, and Microsoft Teams.

Methods for identifying stakeholder groups varied across departments with each department working with its internal Departmental Faculty Advisory Committee (DFAC) and External Advisory Committee (EAB) to identify stakeholders from whom to seek input. Some examples from specific departments are presented here.

The Department of Animal Sciences is establishing a new EAB for the Feed Technology Center (https://aces.illinois.edu/research/facilities/feed-technology-center). The department will host meetings with the Illinois Pork Producers Association Board of Directors, the Illinois Beef Association Board of Directors, the Illinois Farm Bureau, and the Corn Growers Association. The department head participated in the Illinois Livestock Development Group meetings, attended the Illinois State Fair, the Illinois Pork Expo, and participated in several commodity group meetings.

The Department of Food Science and Human Nutrition meets annually with stakeholders from industry, government, and academia (FSHN External Advisory Committee) to solicit input on research and scholarly activities. The committee structure was modified slightly to be more responsive to undergraduate focal areas such as Dietetics, Hospitality Management, Food Science, and Human Nutrition). Collaborative discussion with faculty provide feedback to the department. FSHN alumni are invited to various events and respond to surveys asking for input. The Center for Advanced Research in Drying has two annual meetings with stakeholders, including industry representatives.

The Department of Natural Resources and Environmental Sciences identified stakeholders and collected stakeholder input through:

1. Sharing results from a project focusing on the effects of herbicide, reseeding of native plants, and prescribed fire on invasive plants with the Iowa Department of Natural Resources, the Missouri Department of Conservation, and The Nature Conservancy
2. Working with natural resource managers and the farming community to enhance research results from work with insectivorous bats in controlling crop pests
3. Conducting bat walks as part of public outreach activities along with online presentations
4. Presenting at the 2021 Society of Wetland Scientists conference in June 2021, which was attended by academic ecologists, land managers, restoration practitioners, and government agency personnel involved in natural resource management
5. Collaborating with natural resources managers to study the use of habitats by birds to understand why certain species populations increase or decrease
6. Targeting agriculture and soil science conferences and peer-reviewed journals to improve the aquatic environment with nitrogen and phosphorous management
7. Engaging with farmers interested in ways to evaluate and document benefits of soil stewardship
8. Presenting at the Practical Farmers of Iowa annual conference and the Pennsylvania Sustainable Agriculture Association.

Methods for collecting stakeholder input and brief explanation

ACES researchers present research results and intermediate reports in forums that allow stakeholders to provide input and feedback. Stakeholder feedback is also secured during annual meetings of departmental external advisory committees and other informal engagements with organizations.

In FFY 2021 Hatch and Multistate Hatch supported research under the Safe, Plentiful and Accessible Food Supply Critical Issue was presented at national and international conferences including:

- Society of Nematologists
- Soil Science Society of America
- Crop Science Society of America
- American Society of Agronomy
- American Association of Candy Technologists
- International Congress of Plant Pathology
- International Association for Food Protection
- Waste Food Action Alliance
- Institute of Food Technologists
- American Chemical Society
- Maize Genetics Conference

- North Central Weed Science Society
- Weed Science Society of America

In FFY 2021 Hatch and Multistate Hatch supported research under the Community Involvement, Inclusion and Leadership Critical Issue was presented at national and international conferences including:

- National Council on Family Relations
- Society for Research in Child Development
- Illinois Farm Bureau
- International Food Policy Research Institute
- World Bank

In FFY 2021 Hatch and Multistate Hatch supported research under the Safe, Healthy Environments and Behaviors Critical Issue was presented at national and international conferences including:

- Association for Chemoreception Sciences
- Women's Malignancies Program Seminar Series
- Food Waste Action Alliance
- Society for Food Nutrition Education and Behavior
- Society for Research in Child Development
- International Society for Developmental Psychobiology
- European Society for Pediatric Gastroenterology, Hepatology and Nutrition
- Nutrition 2021
- International Association for Relationship Research

In FFY 2021 Hatch and Multistate Hatch supported research under the Economic and Workforce Development Critical Issue was presented at national and international conferences including:

- Agricultural and Applied Economics Association
- Illinois Bar Association
- Leadership Educators Institute
- National Leadership Symposium
- World Food Center
- USAID Feed the Future Innovation Labs
- Commodity and Energy Markets Association
- International Symposium of the JP Morgan Center for Commodities
- Asia-Pacific Association of Derivatives
- French Finance Association
- Centrec
- Ulvön Conference on Environmental Economics
- Southern Economics Association Meetings
- Canadian Environmental and Resource Economics Association

In FFY 2021 Hatch and Multistate Hatch supported research under the Thriving Natural Resources Critical Issue was presented at national and international conferences including:

- Society of Experimental Biology
- Environmental Change Initiative
- Center for Behavior, Institutions, and the Environment
- Nature Conservancy
- World Soil Day Celebration
- Soil Science Society of America
- Iowa Department of Natural Resources
- Missouri Department of Conservation
- Orthopedic Research Society
- Conference of Research Workers in Animal Disease

- North American Porcine Reproductive and Respiratory Syndrome Conference
- Illinois Mosquito and Vector Control Association
- Ecological Society of America
- Mycological Society of America
- Urban Wildlife Institute
- Bureau of Land Management
- American Society of Mammalogists

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

At the college level, stakeholder input plays a critical role in the hiring of new faculty members. Positions that were filled or are in process include:

- Assistant Professor of Agricultural Finance, Farm, and Risk Management
  The person in this position evaluates credit and risk carrying abilities of financial institutions and farms, and provides producers, policy makers, and agribusiness professionals with research-based analyses and information on profitability and risk management.
- Assistant/Associate Professor of Environmental Economics
  The person in this position addresses issues at the intersection of agriculture and the environment, including challenges posed by climate change.
- Assistant/Associate Professor of Sustainable Agriculture
  The person in this position studies issues at the intersection of agricultural and environmental systems such as soil health, carbon sequestration, water quality, and habitat conservation.
- Assistant Professor of Agricultural Commodity Markets
  The person in this position focuses on analyses of fundamental supply, demand, and policy factors impacting grain and livestock commodity markets.
- Assistant/Associate/Full Professor of Field Crop Production
  The person in this position blends applied research and scientific communication through Extension and course instruction in field crop agronomy.
- Assistant Professor of Adaptive Genomics of Livestock
  The person in this position will fill a critical void and create opportunities in this rapidly emerging area of high relevance to animal agriculture.
- Assistant Professor of Computational Biosystems Engineering
  The person in this position will build a strong externally funded research program that focuses on design, implementation, and application of computational and data science methodologies and platforms.

The Department of Food Science and Human Nutrition (FSHN) well illustrates the manner in which departments process and use stakeholder input to yield outcomes (such as decisions on staffing needs). Stakeholders reported, for example, that food safety is a growing concern. FSHN responded by working with Pratik Banerjee (Associate Professor in FSHN with a 40% Extension appointment) to create a process for training. The Council for Food Science Administrators (CFSA) developed a white paper on the lack of funding for food science that resulted in a letter of support sent by several members of Congress. Encouraged by this outcome, FSHN is now discussing Diversity, Equity and Inclusion at the Council of Food Science Administrators meeting as well as workforce readiness.

Similarly, the Department of Natural Resources and Environmental Sciences reallocated resources and modified research questions to better address scientific and stakeholder input and needs. Stakeholder input provided both opinion and evidence on trends that impact course content for undergraduate and graduate students. This prompted NRES to conduct an evaluation of programs across teaching, research, and Extension. Key findings from stakeholder input included:

- Opportunities to work with a network of farmers in Champaign County to increase our understanding of the nature of bats and how farmers can benefit from bats' ecosystem services. It also presents an opportunity to engender a more positive perception of bats in the broader public given bats' perceived role in the COVID-19 pandemic
- Increased effectiveness when monitoring natural areas and ecological restoration projects
- Prioritizing bird habitats
- Monitoring the environment by studying insect pest control, dispersal of plant seeds, and control of rodent populations by the study of bird habitats
- Reviewing policy and farmers' preferences that suggests many outcomes equated with soil stewardship are too difficult and costly for individuals to measure on their own (workshop that engaged social scientists with crop breeders and soil scientists reinforced

the need for systems-based efforts)
- Identifying the distinctiveness of urban soils fosters an appreciation of these assets as a key resource to enrich urban dwellers' quality of life

Through similar processes, each department in ACES has made meaningful changes in its curricula, hiring plans, or research priorities.

Highlighted Results by Project or Program

Critical Issue

Community Involvement, Inclusion, and Leadership

REFINING THE ROLE OF CULTURAL RESPONSIVENESS IN LEADERSHIP EDUCATION

Project Director
Vivechkanand Chunoo
Organization
University of Illinois
Accession Number
1021670

REFINING THE ROLE OF CULTURAL RESPONSIVENESS IN LEADERSHIP EDUCATION

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

Leadership education centered on cultured ways of knowing produces workers with culturally responsive leadership capabilities. Culturally responsive leadership preparation is vital to meet the current and future workforce needs in every economic sector, including the food, agricultural, natural resources, and human (FANH) sciences. However, students from historically underrepresented backgrounds continually encounter college instructors with inadequate training, outdated pedagogies, and little experience fostering identity development. As a consequence, some students come to college with leadership and cultural capacities that overshadow the abilities of their instructors and university personnel.

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.

Culturally responsive leadership learning is critical for increasing the number and diversity of students who pursue and complete degrees in the FANH sciences; however, there is little formal training in cultural responsiveness for postsecondary leadership instructors. Specifically, this study seeks to address: 1) How to best prepare leadership educators to teach from culturally responsive perspectives; and 2) How to measure the success of culturally responsive leadership teaching efforts.

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

Answers to the above research questions direct future pedagogical models of culturally responsive leadership learning resulting in improved recruitment, retention, and degree completion of diverse students in FANH science programs. Results of this study have been presented at professional development meetings of the Leadership Learning Research Center at Florida State University as well as Agricultural Leadership, Education and Communications (ALEC) faculty meetings at the University of Illinois at Urbana-Champaign. Additionally, findings have been shared at the biennial Leadership Educators Institute (LEI; 2020), the annual meetings of the International Leadership Association (ILA) in 2020 and 2021, and featured prominently at the 2021 National Leadership Symposium. The implications of this project have also been used to construct the 2020-2025 National Leadership Education Research Agenda.

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

Higher education is a public good. The leadership training, development, and education programs that occur in college also yield public goods. By improving the quality of collegiate leadership education, and by extension enhancing the worth of college experiences, this project adds value to the public good of higher education. While designed toward improving the

educational preparation of the FAHN-science workforce, it also has broad applicability to all undergraduate students who learn leadership in college and university settings.

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.

Emerging findings suggest cultural responsiveness in the processes of teaching and learning leadership is best measured through social justice outcomes, including social justice attitudes, beliefs, behaviors, expectations, relationships, and systems. As this project nears the end of its funding, greater emphasis will be placed on how teachers' responsiveness drives social justice outcomes among their students.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Leadership education centered on cultured ways of knowing produces workers with culturally responsive leadership capabilities. Culturally responsive leadership preparation is vital to meet the current and future workforce needs in every economic sector, including the food, agricultural, natural resources, and human (FANH) sciences. By improving the quality of collegiate leadership education, and by extension enhancing the worth of college experiences, this project adds value to the public good of higher education. While designed toward improving the educational preparation of the FAHN-science workforce, it also has broad applicability to all undergraduate students who learn leadership in college and university settings.

Closing Out (end date 09/07/2023)

COMMUNITY PARTICIPATION AND GENOMIC INTEGRATION FOR HEALTH

Project Director
Margarita Teran-Garcia
Organization
University of Illinois
Accession Number
1018628

COMMUNITY PARTICIPATION AND GENOMIC INTEGRATION FOR HEALTH

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

The Community Participation and Genomic Integration for Health (CPgI4H) project provides a unique research opportunity as studies addressing gene-environment interactions in the pathogenesis of obesity or weight gain trajectories are lacking. The CPgI4H project will provide data for subsequent proposals aimed at developing personalized interventions to optimize child health outcomes.

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 activities included dissemination of findings and proposals in national conferences directed to nutrition educators and public health specialists. The programmatic areas included education to explore the factors related to changes in dietary behaviors of recent immigrant families and the development of culturally-focused programs for intervention. In addition, the investigation of genetic and environmental influences on weight gain trajectories will inform evidence-based, precision nutrition recommendations for preventing pediatric obesity.

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

Target audiences included nutrition educators and Extension specialists, undergraduate and graduate students in the areas of nutrition and health, low-income and low-literacy families will be informed of evidence-based information generated, Hispanic/ LatinX populations will also be targeted with bilingual/bicultural educative materials, and public and scientists in

the areas of nutrition, health, and wellness for children and families. Our team also use this model of community participation to expand in adapting the program for African Immigrants from Nigeria and Congo.

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

We have expanded our reach to underserved population groups and presented our findings in local, regional and national 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.

One major change was related to the biological experiments and the limitations to conduct in-person education during the COVID-19 pandemic. However, the challenge presented the opportunity to develop educational materials in collaboration with Extension educators and to translate information in Spanish for digital dissemination. Professional development was offered to graduate and undergraduate students to improve their communication skills and involvement to engage different communities. In the next period of time a manuscript, submitted for publication, is expected to be published and there are at leas two more in preparation.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The Community Participation and Genomic Integration for Health project fills an unmet need as it studies obesity from both genetic and environmental viewpoints. Programmatic areas include education to explore the factors related to changes in dietary behaviors of recent immigrant families and the development of culturally-focused programs for intervention. The ultimate goal is that the investigation of genetic and environmental influences on weight gain trajectories will inform evidence-based, precision nutrition recommendations for preventing pediatric obesity.

Community: Support strong and resilient youth, families, and communities.

Project Director
Elizabeth Welbes
Organization
University of Illinois
Accession Number
7001935

4-H Youth step up to act, lead, and inspire throughout Illinois

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

According to the Search Institute, young people are more likely to grow up successfully, or thrive, when they experience developmental relationships with important people in their lives. Developmental relationships are close connections through which young people discover who they are, cultivate abilities to shape their own lives, and learn how to engage with and contribute to the world around them. According to the 2018 Illinois Youth Survey, nearly one out of five (17%) eighth graders report there is no other adult (besides a parent or guardian) that they can talk to about important things in life. In one county, 44% of eighth graders reported lack of access to a trusted adult. There is a unique opportunity for 4-H youth development programs to strengthen developmental relationships with young people through intentional program design and club management. Longitudinal research, conducted by researchers at Tufts University, shows that youth involved in 4-H are nearly four times more likely to contribute to their communities and about two times more likely to be civically active than

their peers. Researchers at the University of Massachusetts concluded that adolescent civic engagement is linked with improved health and socioeconomic status in adulthood. Nurturing adolescent leadership and civic engagement will reap immediate and long-term benefits for adolescents and the communities they serve.

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.

Illinois Extension 4-H club programs, 4-H youth development workshops, camps, and events, intentionally support a sense of belonging, promote developmental relationships, and provide opportunities for youth to explore their interests and passions (sparks). In 2021, 2,636 adult volunteers collectively devoted more than 253,000 hours to provide 16,385 youth with a 4-H club experience. Volunteer training and support is an essential contributor to effectiveness. For the first time, volunteers from across the state met virtually as part of the new Café Conversations series, gaining access to tools, techniques, and peer networks. Topics covered in the virtual series helped support volunteers to strengthen clubs and subsequently maximize positive member experiences. Club members were very active in 2021, enrolling in more than 55,800 different 4-H projects to explore their sparks, learn new skills, and make a difference in their communities. In fact, the majority (93%) of Illinois 4-H members work on community service projects that help their community.

In addition to engagement in local projects, statewide leadership initiatives enable 4-H teens to expand their network, skills, and confidence. The **Illinois 4-H Youth Leadership Team**, comprised of 20 high school aged 4-H members in 2021, annually plans and leads statewide events that support leadership development among their peers and younger 4-H members. One such event, the *Illinois 4-H Junior Leadership Conference* held in October 2020, offered 105 junior high aged youth opportunities to explore new 4-H project areas, learn activities and games they can take home to their 4-H clubs, learn and practice new leadership skills, and interact with other 4-H members from around the state.

Statewide leadership opportunities for 4-H teens take many forms. The 9 member **Illini Summer Academies Teen Production Team** transformed an annual in-person event to a fun and unforgettable virtual experience for 134 high school participants in 2021. *Illini Summer Academies (ISA)* provides a venue for youth to explore college and career options before committing to one path. University of Illinois faculty led exploratory courses from College of Engineering, College of Veterinary Medicine, College of Liberal Arts and Sciences, College of Agricultural, Consumer, and Environmental Sciences, College of Education, and Gies College of Business.

The **Illinois 4-H Food Advocacy Team,** a group of 15 teens and young adults, provides dynamic leadership to increase their impact on the future of food in Illinois. Team members influenced development of the *Illinois Food Action Summit*, held in May 2021. Summit participants met virtually to be inspired and share a vision for food security, food access, and food justice in Illinois. University of Illinois researchers, non-profit professionals, food advocates, and civic leaders led workshops designed to empower 105 young people with the knowledge, confidence, and resources they need to strengthen their leadership as they work to create food security in their communities.

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

Across Illinois, 4-H members used their head, heart, hands, and health in 2021 to make a difference in their communities. Examples of 4-H service to impact their communities include:

- **Addressing food insecurity-**Volunteers assembled over 1,000 food bags in conjunction with a local food bank for disaster relief shipments to families in need. In addition, one Teen Teacher SPIN club collected more than 100 items in a food drive challenge to support the Illinois 4-H Food Advocacy Team. Another club, in one of the most economically disadvantaged Illinois counties, hosted a multi-site food drive to help raise food donations for the community.

- **Enhancing access to outdoor spaces-**Knowing that engagement with outdoor spaces provides a host of health and other benefits to community members, 4-H club members worked to clean up and beautify local parks through planting new flower beds, installing fire pits for outdoor gathering spaces, and building park and picnic benches to be used in local parks and community centers.

- **Creating connections and supportive networks-**One 4-H club launched a letter writing campaign to connect with and thank military veterans. Youth from another club used storytelling interviews to "introduce" local immigrant-owned businesses to the community, fostering new interactions and conversations and increasing a sense of community belonging for business owners who were new to the community.

- **Protecting the environment-**Youth and adult volunteers participated in the Illinois RiverWatch citizen science initiative that teaches citizens how to collect data on an "adopted" stream and report findings to a centralized database used to safeguard Illinois' rivers and streams. Another citizen science initiative, Nestwatch, engaged 4-H youth in observation and data collection tasks to better understand nesting requirements of the Barred Owl to inform design of nesting boxes for this particular species that lives throughout the state of Illinois.

Through planned events supported by statewide 4-H leadership teams, conference and summit participants learned more about their "sparks and how to make a difference while fostering a sense of belonging, so central to the 4-H experience. The majority (94%) of *Illinois 4-H Junior Leadership Conference* participants felt like they mattered at the conference and 93% felt that the conference gave them the opportunity to explore something they really cared about. One participant shared that "*Attending the 4-H Junior Leadership Conference gave me an opportunity to learn more about the qualities of a good leader. My key takeaways were to plan and be prepared, be open-minded, communicate, persuade and influence, and have confidence in your delivery skills*". A member of the Illini Summer Academies (ISA) Production Team described her experiences on the team as *"Unforgettable, I felt like joining the production team helped me grow but also I felt included. I really feel like it was such a once in a lifetime experience".* ISA participants clearly benefited from the academies in that the majority (74%) felt they had a better idea of what they might actually do after high school and felt that ISA helped them identify careers that might be a good fit for them. The *Illinois Food Action Summit* attendees indicated they felt motivated to take action on food security where they live, as reported by 89% of youth.

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

These examples of community service and statewide leadership demonstrate how 4-H members and volunteers lean into Illinois Extension's 4-H program theme of "Stronger Together… ACT | LEAD | INSPIRE". Through both structured and organically grown 4-H leadership opportunities, youth are motivated to influence others and are comfortable working in partnership with other teens and adults to achieve a goal. These experiences are consistent with findings from the a North Central Region 4-H Volunteer Study, in which 93% of respondents agreed that volunteering with 4-H makes communities stronger and 78% agreed that volunteering with 4-H increases civic engagement. Given the connection between adolescent civic engagement and improved long-range health and economic conditions, Illinois Extension 4-H programs and projects contribute to reduced societal costs associated with poor health and economic instability.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Illinois Extension 4-H club programs, youth development workshops, camps, and events provide a safe space for youth to thrive, experience success, and explore their sparks. In 2021, more than 2,600 adult 4-H club volunteers devoted more than 253,000 hours to provide 16,385 youth with a 4-H club experience. 4-H youth made a difference in their communities by addressing food insecurity, enhancing access to outdoor spaces, creating connections and supportive networks, and protecting the environment. Statewide leadership opportunities complemented local programming, empowering adolescents to collectively design and implement 4-H leadership conferences, Illini Summer Academies, and influence the development of the Illinois Food Action Summit. Because adolescent civic engagement is linked with improved health and socioeconomic status in adulthood, leadership opportunities reap immediate and long-term benefits for adolescents and the communities they serve.

Local government officials and community leaders access resources to benefit Illinois communities

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

Building leadership capacity among community leaders and elected officials is critical to community viability and sustainability. Increasing the capacity of local decision-makers in the areas of communication, decision-making, teamwork, and economic stability will enhance community vitality and improve the quality of life in rural and urban areas alike. When leaders build their own competencies and effectiveness, they can significantly influence lives of residents across entire communities and regions.

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.

As COVID-19 continued to impact governments, businesses, and communities, Illinois Extension's Local Government Education (LGE) program increased its outreach aimed at economic investment and community vitality, workforce development, leadership, policy, equity, and resiliency. LGE webinars help officials and community leaders across Illinois stay informed of policy issues and emerging trends, as well as learn about ways to benefit their communities. The LGE webinars are offered at no cost, accessible across the state, are each a feasible one hour time commitment, and can also be viewed on-demand (after the live webinars are recorded) via easy to access online archives. In 2021, 3,962 participants viewed 60 LGE webinars. Webinar recordings, posted to the Illinois Extension website, generated an additional 4,133 views. Registered participants spanned 231 Illinois cities and villages. Highlights from 2021 include:

- More than 2,000 viewers learned about leadership, public service, and community involvement
- Extension helped more than 1,000 viewers expand their understanding of how to meet the needs of diverse or vulnerable populations.
- As additional federal and state assistance increased demand for investment planning and strategies, nearly 4,000 viewers learned about how to utilize opportunities and programs
- Resiliency, whether economic or environmental, has never mattered more. More than 1,000 viewers joined these conversations to sustain and strengthen their communities.

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

LGE viewers completed a poll during many of the live Zoom webinar broadcasts to assess self-reported knowledge improvement based on information and resources presented in each webinar. Overall, 94% of respondents reported improved knowledge in the webinar topic and 70% reported that their knowledge improved "*considerably*" or "*a lot*". Webinar topics with the highest share of participants reporting that their knowledge increased "*considerably*" or "*a lot*" include:

- Rural Partners Hancock County Addiction Coalition (92%)
- Rural Partners Farm Family Resource Initiative (90%)
- Rural Partners Telehealth--The value of telemedicine to rural economies (89%)
- Rural Partners Illinois Demographic Trends--Illinois population changes per the 2020 Census and potential implications (87%)
- Illinois Housing Development Authority Assessing Community Needs--IHDA's place-based programs aimed at expanding affordable housing (87%)

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

When local government and community leaders gain knowledge on how to improve access to resources that support connected, healthy, and economically vital communities, residents across the state benefit. Based on webinar registrants who reported a role in local government or a local governing board, residents from 112 different communities in Illinois have the opportunity to benefit from what their local leaders gained from the 2021 Local Government Education webinar series.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Community residents rely on local government officials and community leaders to use trusted and objective information when making decisions that affect community vitality and resilience. In 2021, 94% of 3,962 Local Government Education webinar participants reported improved knowledge in one or more webinar topics related to leadership, public service, inclusive community involvement, economic development. Based on registrants who reported they have a role in local governing, residents from 112 different Illinois communities can benefit from their local leaders' participation in Extension's popular and trusted Local Government Education webinar series.

Critical Issue

Economic and Workforce Development

PRICE AND TRADING DYNAMICS IN AGRICULTURAL COMMODITY MARKETS

Project Director

Joseph Janzen

Organization

University of Illinois

Accession Number

1026152

PRICE AND TRADING DYNAMICS IN AGRICULTURAL COMMODITY MARKETS

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

This project addresses price dynamics in agricultural commodity markets with specific emphasis on corn, soybeans, and other field crops important to the U.S. Midwest. It describes how prices change over time and identifies causal factors related to the specific actions of producers, consumers, and market intermediaries like traders and processors underlying those changes. Understanding these causal relationships is crucial for informed business decision making and appropriate government policy in agriculture.

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 this period, I conducted data analysis related to: i) Policy responses to the U.S.-China trade war and COVID-19, ii) Grain storage activity by U.S. farmers and grain merchants, and iii) Changes in farm-level decisions related to grain storage and marketing and organic certification. Understanding past behavior in these domains provides important insight on the interrelationships between output market prices, input market prices, and policy and management responses that are a key objective of this project.

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

U.S. farmers and other firms in the grain supply chain have an improved understanding of how unanticipated changes in government policy may affect price relationships and the resulting decisions of other firms in the agricultural supply chain both in the present and the future.

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

The activities under this project are important to the broader public because commodity price levels and price volatility affect the adequacy and cost of global food supply. Further, the distribution of economic benefits in agriculture is important for understanding the health of rural communities. Finally, research under this project is useful in assessing the efficiency and effectiveness of government policy for agriculture which use of public funds.

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.

Work during this period resulted in two publications in peer-reviewed academic journals:

Fuller, K.B., Janzen, J.P. and Munkhnasan, B., 2021. Farmland Rental Rates: Does Organic Certification Matter?. *Land Economics*, *97*(1), pp.80-106.

Janzen, J.P., Malone, T., Schaefer, K.A. and Scheitrum, D.P., 2021. Political returns to ad hoc farm payments?. *Applied Economic Perspectives and Policy*, forthcoming.

The following work was presented at a national academic conference:

Janzen, J., Swearingen, B. and Yu, J., 2021. Buying Time: The Effect of MFP Payments on the Supply of Grain Storage. Paper presented at the Annual Meeting of the Agricultural and Applied Economics Association, Austin, Texas.

Results from ongoing work on grain storage was also disseminated to stakeholders in articles published to *farmdoc daily*, an online platform for agricultural Extension and outreach hosted by the University of Illinois.

Future activities includes the submission of research papers on the effects of government program payments on grain storage to academic journal and continued analysis of farm-level storage decisions using data from the Illinois Farm Business Farm Management Association.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The activities under this project are important to the broader public because commodity price levels and price volatility affect the adequacy and cost of the global food supply. Further, the distribution of economic benefits in agriculture is important for understanding the health of rural communities. Finally, research under this project is useful in assessing the efficiency and effectiveness of government policy for agriculture which uses of public funds.

THE COSTS OF REAL TIME TRADING OF USDA REPORTS

Project Director
Maria Teresa Serra Devesa
Organization
University of Illinois
Accession Number
1019569

THE COSTS OF REAL TIME TRADING OF USDA REPORT

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

The objective of this project is to revisit the value of USDA reports in the electronic era by identifying the efficient price return variance of corn and soybean futures prices following the report release.

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.

Major accomplishments during the reporting year relate to the revision of the two articles initiated in the previous year according to referee reports. Both articles were accepted, one in the European Journal of Operational Research, the other in the Journal of Agricultural Economics.

The details are as follows:

First Research Article:

Bian, S., T. Serra, P. Garcia and S. Irwin. 2021. New Evidence on Market Response to Public Announcements in the Presence of Microstructure Noise. European Review of Operational Research, Forthcoming. https://www.sciencedirect.com/science/article/abs/pii/S0377221721006251.

Abstract:

Market responses to public news announcements are commonly measured by their impact on price returns variance, which allows inference on the value of information and the length of the price discovery process. Recently published articles based on high-frequency data fail to disentangle efficient market price variance from microstructure noise, which produces biased estimates of announcements' market impacts. By using a Markov Chain framework, we address the shortcomings of previous research and assess the market response to key public information releases affecting agricultural markets. We compare two mechanisms to release public information that have been used in these markets: The trading halt and the real-time. We show how the value of microstructure noise can be used to improve public policy decisions. We find that the real-time release of information brings faster efficient price discovery at the cost of large microstructure frictions. Increases in the cost of noise are not compensated by the improvements in the speed of efficient price discovery. Overall, our findings are highly relevant to public policy and have implications for market design.

Second Research Article:

Huang, J., T. Serra, P. Garcia and S. Irwin. 2021. To Batch or Not to Batch? That Is the Question. Agricultural Economics, Forthcoming. https://onlinelibrary.wiley.com/doi/abs/10.1111/agec.12667.

Abstract

In 2012 the USDA began releasing crop reports during trading hours. Prior reports were released during a trading halt, and in the electronic trading platform traders competed in a batch auction for two hours. Compared to the current real-time release policy, the batch auction reduced speed advantage, lowered market volatility, and improved liquidity around report releases, at the cost of delaying price discovery. The results reported here support the argument that the development of a shorter batch auction could improve on the lengthy price discovery process while maintaining the batch auction's other advantages. These findings are relevant to not only developed countries with well-established exchanges and public information systems, but to developing countries who have recently launched or are planning to launch futures commodity markets.

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

Target audiences of the project include the following:

First and foremost, the USDA as we assess the impacts of report release policies.

Second, CME as the project provides policy recommendations that should be implemented by the exchange in order to improve market quality.

Third, agricultural futures market participants, as it identifies the implications of participating in the market during report release days.

Finally, we also make a relevant scientific contribution which allows us to include the scientific community within the target audience.

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

The broader public may benefit from the project's activities as it sheds light on the value of public information that is very costly to produce, as well as on the the distribution of the profits from trading on public 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.

What opportunities for training and professional development has the project provided?

Training activities during this year have mainly focused on intensive teamwork involving the PhD students and their mentors.

How have the results been disseminated to communities of interest?

Results have been disseminated through two academic publications as discussed above.

What do you plan to do during the next reporting period to accomplish the goals?

During the next year we will continue to work in this area by investigating the relevance of speed in order to profit from public information released through scheduled USDA reports.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

This project seeks to revisit the value of USDA reports in the electronic era by identifying the efficient price return variance of corn and soybean futures prices following the report release. Our work addresses the shortcomings of previous research and assesses the market response to key public information releases affecting agricultural markets, resulting in findings that are highly relevant to public policy and have implications for market design. Our work also compared the impact of releasing crop reports during trading hours versus during a trading halt (and having traders compete in batch auctions). Our results support the argument that the development of a shorter batch auction could improve on the lengthy price discovery process while maintaining the batch auction's other advantages (these findings are relevant to not only developed countries with well-established exchanges and public information systems, but to developing countries who have recently launched or are planning to launch futures commodity markets).

AN INTERGENERATIONAL PERSPECTIVE OF FINANCE AND HEALTH

Project Director

Yilan Xu

Organization

University of Illinois

Accession Number

1014610

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

The long-term goal of this project is to improve social mobility and to enhance financial and health wellbeing. Specifically, my research agenda for the proposed project is to study the intergenerational transmission of finances and health and to investigate the genetic and environmental influences on finance and health. This project is expected to result in a greater understanding of social mobility in terms of how the human capital of financial capability and health is transmitted across generations in a family.

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.

So far, I have developed a research portfolio on the intergenerational perspective of the interaction between health and finance. During the reporting period, I published three papers under this theme. Xu and Yao (2021) used a comparative advantage theory to investigate the intra-household financial decision-making responsibility allocation among old adult families and its relationship with wealth accumulation. Xu and Yilmazer (2021) differentiated the contributing features of childhood prolonged and transitory material hardship to adulthood weight and health. Xu (2021) showed that parental home foreclosure is correlated with lower homeownership of their children compared to their peers who do not experience a parental foreclosure.

- Xu, Y., and Yao., R. 2021. Financial Decision-making Responsibility and Household Wealth Accumulation Among Older Adults: A Comparative Advantage Perspective. Journal of Financial Counseling and Planning, 31 (1), 1-21.

- Xu, Y., and Yilmazer, T., 2021. Childhood Socioeconomic Status and Adulthood Obesity and Health: The Role of Permanent and Transitory Income. Social Science and Medicine.114178. [Impact factor: 3.616].

- Xu, Y. 2020. Foreclosed American Dream? Parental Foreclosure and Young Adult Children's Homeownership. Journal of Family and Economic Issues, 41, 458-471. [Impact factor: 0.921].

The unexpected event of the COVID-19 pandemic provides an opportunity to study health and finance during the COVID-19 pandemic. I completed three papers under this theme during the reporting period. Xu and Yao (2022) examined households' financial vulnerability during the pandemic using the PSID data, with a ranking of various household groups by their financial vulnerability and the first estimate of the number of households at various degrees of financial vulnerability. Yao, Xu, Zhang (2022) extended the existing measures of financial resilience to account for households' ability to adjust expenses and receive nonlabor income when labor income was interrupted, which was the case with many households during the pandemic. The paper also investigated the relationship between COVID-19 health risk conditions and household financial resilience. Xu et al. (2022) studied the health and economic considerations behind consumers' online shopping decisions during the pandemic, using a survey design implemented through the RAND American Life Panel Omnibus Survey in October 2020.

- Xu, Y., and Yao, R. 2022. The U.S. Household Financial Vulnerability: Prediction Analyses in the COVID-19 Pandemic. Journal of Financial Counseling and Planning. 33(1), 1-16.

- Yao, R., Xu, Y., Zhang, J. 2022. Household Financial Resilience from a Health Perspective. Under Review at Journal of Consumer Affairs. [Impact factor: 1.86].

- Xu, Y., Heo, W., Kiss, D.E., Cho, S., Gutter, M. 2022. Pushing or Clicking the Grocery Cart? Health and Economic Concerns During the COVID-19 Pandemic. Journal of Consumer Affairs. Revised and resubmitted. [Impact factor: 1.86].

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

I have devoted myself to disseminating and communicating my research findings to both domestic and international audiences as well as those inside and outside of the field of family and consumer science and household finance. My research has been presented to the family and economic research communities and domestic and international audiences through multiple publications in peer-reviewed journals, social media, the NC-2172 website, and my website. Due to the interruption of COVID-19, conference presentations are more limited and available ones are virtual.

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

This project is important for its potential contribution to the field of family and consumer economics. The findings will provide a foundation for developing, implementing, and evaluating initiatives of educational and behavioral interventions to improve finance and health. The research outputs are expected to inform stakeholders of the dynamics of intergenerational transmission of finance and health. Policy interventions may be formulated accordingly to improve social mobility.

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.

Sebastien Box-Couillard and Julian Diaz, Ph.D. students at the Department of ACE at the University of Illinois, were hired during the reporting period to support my research projects. While they were assisting the data analysis, literature review, manuscript preparation, they were trained to be independent researchers.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

This project is important for its potential contribution to the field of family and consumer economics. The findings will provide a foundation for developing, implementing, and evaluating initiatives of educational and behavioral interventions to improve finance and health. The research outputs are expected to inform stakeholders of the dynamics of intergenerational transmission of finance and health. Policy interventions may be formulated accordingly to improve social mobility.

Economy: Grow a prosperous economy

Project Director

Elizabeth Welbes

Organization

University of Illinois

Accession Number

7001934

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

Professionals across multiple workforce sectors require certification or licensure to secure and maintain employment in their profession. These certifications and licensures provide evidence that professionals demonstrate competencies central to their role and that these competencies are continually refreshed. Examples of professionals requiring certification and/or licensure throughout their careers include K-12 teachers, certified crop advisors, and certified food protection managers. According to the Livestock Management Facilities Act, livestock facilities in Illinois that house 300 or more animal units are required to have at least one person certified in the environmental protection aspects of manure management. Livestock operations without a certified livestock manager risk non-compliance, often affecting not only employees but also the entire operation. Professionals across these diverse work environments need effective preparatory and continuing education to demonstrate competencies and retain their professional income.

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.

Illinois Extension has partnered for many years with Illinois administrative and regulatory agencies to serve as an approved provider of professional certification education and, in some cases, is approved to administer tests required to demonstrate evidence of mastery at a sufficient level to secure or renew certification. Professional development opportunities are provided by Illinois Extension through online, in-person, and mixed (hybrid) methods of delivery. Examples of professional education Illinois Extension delivered in 2021 include:

Extension educators provided 33 **continuing education programs targeting 421 K-12 teachers** addressing a variety of topics relevant to their professional growth and to advancement of research-based practices that can positively influence their classroom environment and students. Examples of topics include integration of STEM, social emotional learning, cultural competence, and gardening/nature into curricula and classroom practices. One long standing continuing education program, *Incubation and Embryology*, provides hands-on activities and equipment to implement a module that applies STEM concepts through caring for and hatching eggs in the classroom. Illinois Extension (in collaboration with the University of Illinois, College of Education) is an Illinois State Board of Education approved provider of continuing education that confers professional development hours required for maintenance of teaching certificates in Illinois. Teachers reported high levels of agreement that the professional development they attended aligned with their professional growth and/or student growth.

CropFlix, a series of 21 self-directed online modules hosted on the Moodle learning management platform, supports translation of latest research to practice for crop producers, agribusiness professionals, and **certified crop advisors**. When pandemic restrictions prohibited holding the popular in-person 2021 Crop Management Conferences (historically held annually in 4 locations throughout Illinois), commercial agriculture educators within Illinois Extension developed the CropFlix modules to ensure that certified crop advisors were able to secure CEUs to maintain certification despite the pandemic. Module topics addressed regional growing season outlook and review, sustainable crop management practices for insect and pathogen control, soil biology, and specialty crop production strategies. A total of 42 certified crop advisors completed at least one course module with an average of 13 modules completed per advisor.

Four (4) Certified Livestock Manager trainings (CLM) were delivered through live webinars with 115 **livestock managers and producers** in 2021. An additional 186 livestock managers and producers completed a self-directed online CLM course, offered for the first time in 2021. The webinar-based trainings were facilitated by a collaborative team including an Extension educator, an Extension faculty specialist and an Illinois Department of Agriculture (IDoA) representative. Topics included best practices for safe and productive nutrient management and for reducing negative environmental impact of livestock operations. The audience was comprised of livestock owners (70%), managers (18%), and other employees of livestock operations (10%). The majority (64%) identified swine as their primary livestock, 22% reported beef, and 9% primarily managed dairy cows. The new online training and testing option was well received, with observations such as *"Keep this online training as an option once COVID is gone. As producers, we cannot always afford to send our people off for a day of training, and also (especially in swine) biosecurity concerns exist with hanging out in a room for training with other swine producers. This online training will allow us to get this training in the hands of more employees."*

Nutrition and wellness educators provided 28 Certified Food Protection Manager (CFPM) trainings to 291 managers of commercial and "cottage" food industry establishments. This 8 hour program is an American National Standards Institute (ANSI) accredited course, which meets the Illinois Department of Public Health's Food Service Sanitation Code requirements. Illinois regulations require food establishments, facilities, and cottage food vendors to have at least one **certified food**

protection manager on staff. The course is designed to prepare food managers with competencies sufficient to pass the National Registry of Food Safety Professionals exam, proctored by Illinois Extension educators, with a passing score of 75% or higher.

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

Economic value to professionals who earned CEUs or certifications though Extension programs can be estimated through a methodology used by TEConomy Partners, LLC. The firm specializes in impact assessments and conducted a comprehensive economic and functional impact analysis outlined in *The Economic and Functional Impact of University of Illinois Extension* report released in September 2020.

As a result of continuing education programs completed by K-12 teachers, **421 teachers** were awarded professional development hours to maintain their Illinois teaching certificate. The majority (89%) reported that the course they attended *will lead to improved learning for students* and 80% reported that "*the professional development aligned to my performance as a teacher*". With an average annual salary of $70,700 among Illinois teachers in 2021, according to the Illinois State Board of Education, Extension's continuing education programs contributed to retention of more than $29M of Illinois teachers' salary income.

Certified crop advisors earned a total of 492 CEUs across the 2021 CropFlix online series**.** Based on an average annual salary of $45,922 earned by crop advisors in Illinois (according to ZipRecruiter), CropFlix played a role in helping support an estimated $1.9 million in combined annual pay for 42 crop advisors who secured CEUs, an essential requirement for their continued role as a Certified Crop Advisor.

In 2021, 301 **livestock producers and managers** were certified as a result of completing the CLM training. For those affiliated with operations that exceed 1,000 AU, they must also pass a test to demonstrate mastery of course content. With 18% of program attendees (N=54) identifying as managers of a facility and an average annual salary of $45,495 for Illinois swine farm managers (according to ZipRecruiter), the 2021 CLM trainings and testing contributed to an estimated $2.4 million in economic value of combined wages for livestock managers.

A total of 129 **food managers** successfully passed the National Registry of Food Safety Professionals exam to secure or maintain their job essential professional certification. In addition, CFPM training participants who completed a 6 month follow-up survey reported improved food handling, storage, and safety practices as a result of the program. Bureau of Labor Statistics 2020 data for Illinois indicate that food service managers in Illinois earn an average annual salary of $53,090 per year. Extension's CFPM training and testing services contributed to an estimated $6.8 million of combined pay earned by food management professionals in Illinois.

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

A vibrant and skilled professional workforce supports the Illinois economy, by reducing rates of unemployment and contributing to the tax base that funds public services and infrastructure. In addition to the personal economic value of professional development offered by Illinois Extension (estimated at more than $41 million in professional wages across 646 participants in 2021), professionals in the education, agriculture, and food industry sectors are able to use the competencies they gain to influence the lives of others. Teachers have the power to improve the quality of education for the students they serve. Based on the popular *Incubation and Embryology* professional development program, 134 trained teachers collectively reported using the STEM focused curriculum with more than 11,500 students in their classrooms. Crop advisors apply what they learn to assist producers adopt sustainable and economically beneficial crop management practices. Food managers practicing safe food handling can reduce the costly impact of food borne illness. Certified livestock managers have the capacity to minimize environmental hazards that threaten air and water quality. Extension's professional development programs amplify impact and value far beyond the scope of the professionals served.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Because of Extension programs offering continuing and professional education in 2021, 646 professionals (including K-12 teachers, certified crop advisors, certified food protection managers, and livestock managers) secured employment-essential certifications and continuing education credits to support more than $41M in wages and earnings. Through competencies gained and continued employment, these professionals in turn have the potential to influence the lives and livelihood of youth, producers, and the public.

Crowd sourced data supports policies and practices that impact industrial hemp operations

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

In 2018, the USDA issued the "Interim Final Rule for the Domestic Production of Hemp," legalizing production of hemp in the United States for the first time in nearly 70 years. Industrial hemp can be grown to produce fiber, grain, and cannabinoids. Some cannabinoids determine profitability potential (CBD and CBG, for example) while one cannabinoid (THC) determines compliance. Growers must harvest hemp crops which test below 0.3% THC in order to be compliant with state and federal regulation or risk crop destruction/penalties. Due to federal regulations and limitations in the past, there is a severe lack of university-published resources for industrial hemp production. As a "new" crop to Midwestern agriculture, best management practices (BMPs) and varietal performance of industrial hemp have yet to be determined including planting methods, variety performance, fertility requirements, rotational impacts, and compliance. Lack of scientific data supporting or refuting regulations outlined in the Interim Final Rule for Domestic Production of Hemp was the most common source of public complaints.

Information from the Illinois Department of Agriculture (IDOA) as well as a needs-based assessment conducted by University of Illinois Extension have shown a tremendous need for information on variety performance and best management practices for industrial hemp in Illinois. Results of program evaluations and needs assessments revealed a strong need for further research and education in this new production area. Respondents selected "cannabinoid levels throughout the growing season" as the most pressing area of 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.

Through associations with researchers and private laboratories in the region, an Illinois Extension commercial agriculture educator (Philip Alberti) constructed the **Midwestern Hemp Database** (MHD) in April 2020. The MHD is a collaboration between University of Illinois Extension, University of Wisconsin-Madison, Michigan State University Extension, Purdue Extension, Rock River Laboratory, and Pride Analytics on Consulting. Participation in this program provides hemp growers an exciting opportunity to receive discounted cannabinoid analysis in exchange for data collection and data sharing. Data and sampling collection protocols were established and agreed upon by the MHD team in accordance with current USDA regulations. The results of the cannabinoid testing, and information on their production systems (variety, planting date, target population, fertilizer rates, etc.), were then publicly accessible through an online interface available at: https://extension.illinois.edu/global/midwestern-hemp-database.

As of 2021, 180 licensed industrial hemp growers have submitted data on agronomic practices and more than 1400 samples for cannabinoid analysis across the four participating states (Illinois, Michigan, Wisconsin, and Indiana).

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

When the USDA reopened the public comment period in fall of 2020 for the U.S. Domestic Hemp Production Program, comments were solicited on several topics including THC Testing and Negligence, Laboratory DEA Certification, Harvest Windows, and Exemptions for Research. In January of 2021, the USDA published the "Final Rule for the Domestic Production of Hemp" that provides updated regulations for the production of hemp in the United States. The USDA Final Rule (which went into effect in March of 2021) includes several substantial rule changes informed by the MHD analysis. Specifically, MHD data contributed to the expansion of the sample-to-harvest window from 15 to 30 days in the USDA Final Rule which reduces the financial risk associated with crop loss and destruction for hemp farmers nationwide. Additionally, MHD data was used to raise the negligence threshold for Total THC, reducing the potential for criminal penalties for hemp growers.

Cannabinoid testing supported through this partnership was valued at more than $100,000 in discounted testing fees for hemp producers. As a result of this "crowd sourced" and timely data, participating researchers and hemp farmers were able to identify suitable hemp varieties and production strategies across the Midwest.

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

This rapid response to address grower needs and inform public policy was an innovative solution that has the potential to impact grower networks across the region and the country. Expanding this program will improve a greatly underdeveloped knowledge base for hemp in our region and continue to enable science to impact policy. Productive industrial hemp operations, guided by an evolving and expanding database, will positively impact the local and state economy.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

By recruiting 180 licensed industrial hemp growers to submit data on agronomic practices and more than 1400 samples for cannabinoid analysis, the **Midwestern Hemp Database (MHD)** collaborators effectively crowdsourced unprecedented data that influenced changes to the USDA Final Rule for the Domestic Production of Hemp regarding THC Testing and Negligence, Harvest Windows, and Exemptions for Research. The MHD is a collaboration between the University of Illinois Extension (lead database administrator Phillip Alberti), University of Wisconsin- Madison, Michigan State University Extension, Purdue Extension, Rock River Laboratory, and Pride Analytics on Consulting. The results of the cannabinoid testing and agronomic performance data are currently available in a publicly accessible interface. In addition to an estimated value of more than $100,000 in discounted testing prices benefiting participant growers, MHD data contributed to the expansion of the sample-to-harvest window from 15 to 30 days in the USDA Final Rule, which reduces the financial risk associated with crop loss and destruction for hemp farmers nationwide. Additionally, MHD was used to raise the negligence threshold for Total THC, reducing the potential for criminal penalties for hemp growers. The goal is to continue to strengthen the power of this tool and further develop its utility to growers, processors, and regulators in 2022 and beyond.

Critical Issue

Safe, Healthy Environments and Behaviors

ILLINOIS UNITED - A DIGITAL HOME FOR TRANSLATIONAL RESEARCH ON SUBSTANCE USE AND FAMILY HEALTH FOR RESIDENTS THROUGHOUT THE STATE OF ILLINOIS

Project Director
Allen Barton
Organization
University of Illinois
Accession Number
1024295

ILLINOIS UNITED - A DIGITAL HOME FOR TRANSLATIONAL RESEARCH ON SUBSTANCE USE AND FAMILY HEALTH FOR RESIDENTS THROUGHOUT THE STATE OF ILLINOIS

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

Substance misuse and conflictual family relationships are two long-standing public health issues that negatively effect individuals and the communities in which they reside. Although efficacious programs have been created, their reach remains limited. As a result, residents in Illinois have little access to evidence-based programming resources addressing these topics.

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 current project has been successfully disseminating two leading efficacious programs to residents throughout the state of Illinois. One program has focused on tobacco cessation and allows Illinois-based businesses to provide tobacco cessation programming to their employees at no cost to the business or the employee. The other program addresses relationship distress and has reached help-seeking couples throughout the state of Illinois. In addition to these programs, a suite of informational resources have been developed address pertinent issues for residents and families in Illinois. Thus, the project has directly addressed the aforementioned problem of lack of access to evidence-based resources among Illinois residents on these topics.

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

For the first program, help-seeking couples were given the opportunity to participate in one of the leading relationship education programs. Preliminary data analyses suggest improvements in multiple domains of relationship and individual functioning at post-program. For the second more recently-launched project, tobacco users were allowed to enroll in an efficacious tobacco cessation program and businesses were allowed to make this program available to their employees. Data collection remains ongoing.

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

Tobacco use remains the leading preventable cause of death in the United States. Decades of research have documented its enormous costs to individuals, their families, and our communities. Distressed couple relationships have negative effects on individuals' health, any children, work, as well as the connections with the broader community. By providing programming that targets each of these areas, the collateral benefits to the public broader are expected to be wide-reaching.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

This project has been successfully disseminating two leading efficacious programs to residents throughout the state of Illinois. One program has focused on tobacco cessation and allows Illinois-based businesses to provide tobacco cessation programming to their employees at no cost to the business or the employee. The other program addresses relationship distress and has reached help-seeking couples throughout the state of Illinois. In addition to these programs, a suite of informational resources have been developed to address pertinent issues for residents and families in Illinois.

SPATIAL PROXIMITY AS AN OBJECTIVE MEASURE OF COUPLE HEALTH

Project Director
Brian Ogolsky
Organization
University of Illinois
Accession Number
1023786

SPATIAL PROXIMITY AS AN OBJECTIVE MEASURE OF COUPLE HEALTH

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

It is essential that couples are aware of and have the tools to maintain relational health in older adulthood because processes of aging itself (e.g., changes in social roles, physical functioning, mobility, responsibilities to others) can cause partners to depend more on each other as they age together. Relational health is known to vary from moment to moment, often without awareness of partners, making single self-reported measures of relational quality a poor proxy for how relational health occurs in daily life. Moreover, self-reported measures are not practical for daily use because they necessitate active participant involvement, which compromises compliance and often result in selective reporting. Unobtrusive measurement strategies, on the other hand, minimize participant burden because they are less reliant on compliance, do not affect couples' daily routines, and provide continuous measurement. Thus, an important first step toward the development of a tool for couples to understand their relational health is to create an unobtrusive behavioral measure that can be monitored in the context of daily life.

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 were able to design, develop, and deploy our proximity sensors to collect data from ten couples. Data from couples were cleaned and analyzed and then presented at a conference and published in a peer-reviewed journal.

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

Information from the study provides key insights into processes of healthy aging. Using our system, we can provide targeted intervention points for improving relationships of older adult couples.

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

Results from our first study were published in a special issue of a peer-reviewed journal article that will help improve methods for understanding the health and well being of older adult couples.

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.

We employed a post-doc as well as two graduate students and provided them with research design, implementation, and analysis training. Results were disseminated at the Biannual Conference of the International Association for Relationship Research and published in a special issue of the Journal of Social and Personal Relationships.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Results from our first study were published in a special issue of a peer-reviewed journal article that will help improve methods for understanding the health and well being of older adult couples. Information from this study provides key insights into processes of healthy aging. Using our system, we can provide targeted intervention points for improving relationships of older adult couples.

Enhancing Rural Economic Opportunities, Community Resilience, and Entrepreneurship

Project Director
Josie Rudolphi
Organization
University of Illinois
Accession Number
1021669

STRESS AND MENTAL HEALTH AMONG ILLINOIS FARMERS

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

Situations that are likely to cause stress are those that are uncontrollable, unpredictable, or uncertain; characteristics often used to describe farming. Commonly reported stressors by farmers include long working hours, financial uncertainty, and seasonality. As a result of these and other factors, farming has been identified as one of the most stressful occupations.

Chronic stress has been associated with adverse physical and mental health outcomes including anxiety and depression in the agricultural population. Within agriculture, anxiety and depression have been associated with work-related injuries, unsafe work behaviors, and impaired work performance. Across all occupational groups, symptoms of depression are associated with increased mortality risk, hypertension and musculoskeletal disorders, and lost productivity.

Illinois farmers are at risk of a myriad of physical and mental health conditions as a result of occupational stress. However, the stress experience of farmers in Illinois is unknown. We are surveying Illinois farmers to identify major stressors (financial, economic, environmental, and interpersonal), the prevalence of mental health conditions, and the prevalence of physical health conditions and agricultural injury.

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 the past year we administered a survey to one thousan agricultural producers in Illinois to estimate the prevalence of anxiety, depression, and substance use among farmers. Data analysis is currently underway. The results from the study will guide the development of mental health and stress resources and inform Extension programs and priorities.

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

This project is currently generating factsheets for farmers that describe the burden of a situation (i.e., alcohol use among farmers) and providing links and recommendations to resources. In addition, conversations with commodity groups and agricultural producer stakeholder groups have generated interest in having the PIs present at conferences and symposiums.

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

This project is generating public awareness for agricultural producer mental health.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Illinois farmers are at risk for a myriad of physical and mental health conditions as a result of occupational stress. However, the stress experience of farmers in Illinois is unknown. We are surveying Illinois farmers to identify major stressors (financial, economic, environmental, and interpersonal), the prevalence of mental health conditions, and the prevalence of physical health conditions and agricultural injury. This project is currently generating factsheets for farmers that describe the burden of a situation (such as alcohol use among farmers) and providing links and recommendations to resources. In addition, conversations with commodity groups and agricultural producer stakeholder groups have generated interest in having our work presented at conferences and symposiums.

Beneficial and Adverse Effects of Natural Chemicals on Human Health and Food Safety

Project Director
Aditi Das
Organization
University of Illinois
Accession Number
1018461

BENEFICIAL AND ADVERSE EFFECTS OF NATURAL CHEMICALS ON HUMAN HEALTH AND FOOD SAFETY

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

Multiple sclerosis is a chronic debilitating disease of the central nervous system (CNS) characterized by episodic neurological dysfunction (relapses) followed by periods of partial recovery (remission). Patients often experience pain, fatigue, and impaired motor coordination. Disease exacerbation likely stems from an aberrant inflammatory response brought on by autoreactive immune cells (T and B cells) in the CNS. Therefore, there exists a critical need to identify new mechanisms of natural therapeutic intervention that exhibit both disease-modifying and neuroprotective properties.

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 identified a dysregulation of omega-3 derived endocannabinoids in an animal model of multiple sclerosis at different periods of disease progression including without sickness, relapse, and remission. These data suggest that treatment with these naturally forming endocannabinoids may inhibit relapses in an animal model of multiple sclerosis. We next tested this hypothesis for the therapeutic efficacy of the omega-3 derived endocannabinoid and discovered that the days to relapse were significantly longer in the treated group compared to the control group. Furthermore, we identified in primary tissue culture models that the driving T-cell subtypes of the disease (Th1 and Th17) are suppressed by the endocannabinoid treatment.

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

Our findings of natural therapeutic intervention with omega-3 derived endocannabinoids benefited researchers in better understanding how different immune cells (that drive disease progression) are influenced. Additionally, there is the potential for identification of key pathways and lipid structures that regulate the beneficial properties of omega-3 lipids.

Furthermore, we held a seminar to the Brazos Valley Multiple Sclerosis Meeting consisting of patients with multiple sclerosis and key multiple sclerosis researchers in the United States and Germany. There was dialogue with patients on identifying how they can better manage their symptoms through dietary components.

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

The broad public benefited from our project's activities as there is a more clear understanding of the mechanisms of how omega-3 derived molecules elicit their beneficial properties, especially in those with a disease characterized by chronic or aberrant inflammation.

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.

A graduate student was trained to execute this project and has given several oral presentations at three invited seminars and a conference. Additionally, this training led to development, submission, and award of internal student-proposed funding at the University of Illinois as an extension of this project.

With these data obtained, a proposal for NIH R01 funding have been submitted to further explore the potential of omega-3 derived endocannabinoids in mediating the resolution of aberrant inflammation through specific cell responses in animal models of multiple sclerosis.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Multiple sclerosis is a chronic debilitating disease of the central nervous system characterized by episodic neurological dysfunction (relapses) followed by periods of partial recovery (remission). There exists a critical need to identify new mechanisms of natural therapeutic intervention that exhibit both disease-modifying and neuroprotective properties. Through our research we now have a more clear understanding of the mechanisms of how omega-3 derived molecules elicit their beneficial properties, especially in those with a disease characterized by chronic or aberrant inflammation.

Closing Out (end date 09/07/2023)

Nutrient Bioavailability--Phytonutrients and Beyond

Project Director
Jaime Amengual Terrasa
Organization
University of Illinois
Accession Number
1017353

PHYTONUTRIENTS AND BEYOND

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

Cardiometabolic diseases are the main leading cause of death worldwide. Certain bioactive compounds have positive effects over these diseases, but the mechanisms that regulate their absorption and accumulation in humans is not clear. Our laboratory utilizes mouse models and cell biology techniques to study the role of phytonutrients and other bioactive compounds in cardiometabolic diseases. More specifically, we focus our efforts on determining the role of vitamin A and carotenoids in atherosclerosis and obesity.

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 past year, we examined the mechanisms that regulate the absorption of three bioactive compounds; beta-carotene, lutein, and vitamin E. We observed that the vitamin A status in the gut regulates the absorption of these molecules.

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

Understaning the mechanisms that regulate the absorption of dietary nutrients is crucial to promoting better uptake. Once taken up by the body, these nutrients will travel to target tissues where they exert their biological functions.

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

By understanding the mechanisms that regulate phytonutrient absorption, we will be able to obtain their maximum benefit.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Cardiometabolic diseases are the leading cause of death worldwide. Certain bioactive compounds have positive effects over these diseases, but the mechanisms that regulate their absorption and accumulation in humans is not clear. Our laboratory utilizes mouse models and cell biology techniques to study the role of phytonutrients and other bioactive compounds in cardiometabolic diseases. Understanding the mechanisms that regulate the absorption of dietary nutrients is crucial to promoting better uptake. Once taken up by the body, these nutrients will travel to target tissues where they exert their biological functions. By understanding the mechanisms that regulate phytonutrient absorption, we will be able to obtain their maximum benefit.

Comprehensive and Integrated Health Promotion and Disease Prevention

Project Director
Elizabeth Welbes
Organization
University of Illinois
Accession Number
7000144

Nutrition programs support healthy decision-making and promote changes to the food environment

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

Illinois has the 27th highest adult obesity rate in the nation, and the 17th highest obesity rate for youth ages 10 to 17. As of 2017, Illinois's adult obesity rate was 31.1%, up from 20.4% in 2000 and from 12.1% in 1990. Parents, guardians and adult family members play a key role in promoting healthy nutrition choices in children. According to the 2018 Illinois Youth Survey, one out of every ten 8th-12th graders did not eat **any** vegetables in the past week. In addition, 28% of 12th graders reported they were physically active on 2 or fewer days in the prior week. Because at least 80% of premature heart disease, stroke and type 2 diabetes diagnoses could be prevented through healthy lifestyle choices, it is imperative for young people to learn the skills they need to make positive food and activity choices early in life. Research has demonstrated that healthy food selection, preparation and consumption can contribute to a lower prevalence of chronic diseases that disproportionately affect limited-resource populations. However, holding individuals solely accountable for making healthy lifestyle choices without also addressing community environments, systems, and policies that make living a healthy lifestyle nearly impossible for vulnerable populations, is like holding fish accountable for surviving in polluted water.

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.

Illinois Extension's most comprehensive programs targeting nutrition, physical activity, and food buying behavior are under the umbrella of the Illinois Nutrition Education Program (INEP). INEP includes the delivery of direct education nutrition programming to youth and adult audiences by Expanded Food & Nutrition Education Program (EFNEP) staff. These outreach

activities are complemented by multi-level interventions combining a strategic blend of direct education and efforts to change policy, systems, and environments through the SNAP-Ed program. INEP programs directly target audiences with limited incomes to promote healthy choices and also support gatekeepers of environments where these audiences eat, learn, live, play, shop, and work. Through professional development and technical assistance (e.g. food pantries, school lunchrooms, early childhood centers), gatekeepers can create environments that encourage healthy food and activity behaviors.

EFNEP equips limited-resource audiences to gain knowledge and skills needed to eat a nutritious diet and to live a healthy lifestyle. Programs are research-based, hands on, and taught by trained peer educators. EFNEP is located in six counties in Illinois - Cook, Peoria, Champaign, Vermilion, Madison, and St. Clair. In 2021, EFNEP made over 8,400 educational contacts through 78 programs reaching 770 adults and 667 youth. Nearly half [49%] of program participants identified as minority and over one-third [32%] identify as Hispanic or Latino, reaching the underserved audiences in Illinois counties at risk for food insecurity with ways to maximize household food budgets.

SNAP-Ed educators provided 94 in-person and online training programs to 2,008 partner agency personnel on a variety of topics that support agency staff to implement and maintain policy, systems, and environmental changes, removing barriers to healthy nutritional choices and food selection. Professional development topics in 2021 included hunger and health, improving health in food pantries, school gardens, garden to cafeteria practices, family engagement strategies, nutrition policy, and healthy eating role modeling in school and early childhood settings.

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

In 2021, EFNEP in Illinois has reported high levels of impact benefiting families with limited resources. Self-report data based on entry and exit measures of behavior documented that 87% of adult participants [N=683] improved their nutrition practices because of their participation in EFNEP educational programs. Two-thirds (69%) showed improvement in three or more diet quality indicators. In addition, 65% of adult participants showed improvement in one or more physical activity behaviors (i.e., exercising for at least 30 minutes, doing workouts to build and strengthen muscles, or making small changes to be more active). Youth EFNEP participants also benefited from nutrition education with 77% of youth improving their knowledge or abilities to choose foods according to Federal Dietary Guidance.

SNAP-Ed partner agency staff were highly satisfied with the professional development opportunities offered with 90% of post-program survey respondents indicating that the workshop met their needs. The majority (95%) reported that they are likely to use resources provided or referenced, 97% intended to share information they learned with others, and 87% learned something during the workshop they plan to use in their work. In addition, technical assistance and environmental assessment support provided by SNAP-Ed educators resulted in 829 nutrition supports adopted by partner agencies to systemically promote and enable selection and availability of nutritional choices by patrons and clients. Educators lent their expertise to help partner agencies secure nearly $275,000 in grants and $287,000 in donations to support policy, system, and environmental changes.

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

According to a 2021 study examining the association between body mass index and health care costs, excess annual health care costs range from $253 to $3,097 per adult and from $116 to $310 per child living with obesity. Based on the 670 adults and 513 youth who reported improved nutritional outcomes because of EFNEP participation, applying the most conservative (lowest) excess health care cost estimates, nearly $230,000 in excess health care costs might be averted annually. Illinois Extension's comprehensive nutrition education, complemented by outreach to support policy, systems, and environmental change, contributes to reductions in the economic burden of chronic disease in Illinois.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

With high rates of adult and child obesity in Illinois, the Illinois Nutrition Education Program (INEP) provides nutrition education and facilitates strategies to support environments that are conducive to healthy choices in communities where the most vulnerable residents live, play, work, and grow. Excess annual health care costs range from $253 to $3,097 per adult and from $116 to $310 per child living with obesity. INEP includes the delivery of direct education nutrition programming with youth and adults to promote knowledge and skills need to eat a nutritious diet and live a healthy lifestyle. In 2021, the Expanded Food & Nutrition Education Program (EFNEP) staff made over 8,400 educational contacts through 78 programs reaching 770 adults and 667 youth. The program were effective in that 87% of adults improved their nutritional practices because of their participating in EFNEP programs. Additionally, 65% of adults improved participation in one or more physical activity behaviors. SNAP-Ed educators provided 94 in-person and online training programs to 2,008 partner agency personnel

on a variety of topics to support carrying out and maintaining policy, systems, and environmental changes that remove barriers to healthy nutritional choices and food selection. Through technical assistance and environment assessments, partner agencies collectively adopted 829 nutritional supports to systematically promote and enable selection and availability of nutritional choices by food pantry patrons and clients. Based on the 670 adults and 513 youth who reported improved nutritional outcomes through participating in EFNEP, the program may have averted up to $230,000 in annual excess health care costs associated with obesity.

Youth and families strengthen competencies that positively impact social and emotional health

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

Mental health is an important contributor to wellbeing and quality of life. Inextricably linked to chronic disease and injury including self-harm, poor mental health can affect all areas of life. Access to mental health services can be an additional challenge in that Illinois has a higher ratio of population to mental health providers (440:1) relative to the national average (400:1) and exceeds 7,000:1 in some Illinois counties. The National Alliance for Mental Illness reported that 38.5% of Illinois residents have experienced poor mental health. In Illinois, 15% of the population has been diagnosed with a depressive disorder that translates to nearly 2 million residents. The pandemic has only exacerbated feelings of isolation and disruption for young people who have spent so much time in remote learning and physically distanced classroom settings.

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.

Illinois Extension delivers a variety of outreach to support mental health. One audience, K-12 teachers, learn how to promote mental health for the most vulnerable students through trauma informed classroom practices. Farm and farm families can access stress reduction resources and information via both digitally delivered and interactive programming. Agency personnel who work with youth participate in professional development to identify early warning signs of mental health struggles. Finally, direct programming with youth and families aims to create “safe spaces” for open discussion around mental health issues.

Your Thoughts Matter, was delivered in 2021 through a 6 session virtual format as a statewide 4-H Special Interest (SPIN) club with 160 youth age 13 and above. Based on the curriculum developed by Ohio State Extension, youth learned about anxiety, stress, depression and related resources they can tap. In addition, teens used this intensive opportunity to improve awareness around the stigma associated with mental health concerns and learned how to promote positive action in their families, schools, and communities. The virtual SPIN club provided increased access to this mental health promotion program, regardless of local capacity or expertise to facilitate the experience. Participants were surveyed following the program to assess both the quality and outcomes of the program. All respondents (100%) felt supported by their peers in the 4-H program. Peer support is crucial when discussing mental and emotional health issues in that safe emotional spaces are an essential ingredient for program quality.

The pandemic has sparked creative program delivery options in many ways. When in-person programming was not yet feasible, two 4-H educators teamed up to create safe opportunities for families to create connections and stimulate conversations about emotional wellbeing. They developed *Connection Corner Family Activity Kits*, packaged with information and activities designed to help youth and families foster connection and manage emotions. Activities included: conversation starters; breathing practices, kindness challenge, emotion tracker, calming glitter jar, and poetry prompts. The kits were delivered to 125 families reaching 230 adults and 274 youth. Most notably, the activity kits reached 108 families of youth not currently involved in the 4-H program. The *family conversation starters* activity was the highest rated and most well attended activity of the program. When asked for feedback, 100% of respondents indicated that the kits were useful, enjoyable, and filled a need.

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

Youth explored their spark and gained new competencies through participating in *Your Thoughts Matter*. Between 90-94% of post-program feedback survey respondents indicated that they:

- know resources related to mental health that they can share with others in need,

- can identify an adult who could give them assistance if they are struggling with a challenging situation, and
- feel they have someone they can reach out to in order to talk about how they feel.

A strong majority (87%) said they learned coping strategies to help deal with stressful situations and are more confident in their ability to talk to others about mental health after participating in the SPIN club.

Connection Corner Family Activity Kits helped increase specific mental, emotional, and social health related skills. For example, 86% of families who responded to a post-program feedback survey indicated that the breathing practices helped them manage their emotions and 78% said that the emotion tracker helped them respond appropriately to their feelings. Furthermore, more than 90% of respondents specified that the poetry prompts and conversation starters helped them build connections with others. Comments from participating families supported evidence of impact. One participating adult stated, "*I was able to do activities with my children that gave me insight into their thinking and allowed us to strengthen our relationship," while another noted, "My kids are both more willing to open up about what they are feeling and why.*"

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

A recent report from Tufts Medical Center and One Mind at Work estimates that depression accounts for a national annual toll of $44 billion in losses to workplace productivity alone. By enabling youth and families to better mitigate the negative impacts of stress and anxiety, Illinois Extension contributes to a higher quality of life, a stronger sense of belonging, and ability of residents to fully engage in the activities that benefit the communities where they live, work, play, and grow.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Mental health is an important contributor to wellbeing and quality of life. Illinois Extension conducts a variety of outreach activities to support mental health including continuing education for teachers, stress reduction programming and resources for farmers and farm families, professional education for community-based agency personnel to identify early warning signs of mental health threats to their clientele, and direct programming with youth and families to foster discussions around mental health. In 2021, 160 youth age 13 and above participated in a statewide, virtual 4-H Special Interest (SPIN) club called Your Thoughts Matter. They learned about anxiety, stress, depression and related resources to tap for managing these contributors to mental health. Between 90-94% of youth participants who responded to the post-program evaluation said they were better able to access resources related to mental health, identify an adult who could provide assistance when struggling with a difficult situation, and reach out to someone in order to talk about how they feel. All respondents of the post-program survey reported feeling supported by their peers in the program, an essential ingredient for creating safe spaces to discuss difficult issues. Another 2021 mental health program, Connection Corner Family Activity Kits, engaged 125 families comprised of 230 adults and 274 youth to spark discussions and create connections about emotional wellbeing. The activity kits helped to increase specific mental, emotional, and social health-related skills as evidenced by one parent's comment, "My kids are both more willing to open up about what they are feeling and why."

Critical Issue

Safe, Plentiful, and Accessible Food Supply

INVESTIGATING WEED RESISTANCE MECHANISMS TO SOIL-APPLIED HERBICIDES

Project Director
Dean Riechers
Organization
University of Illinois
Accession Number
1025006

INVESTIGATING WEED RESISTANCE MECHANISMS TO SOIL-APPLIED HERBICIDES

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

Weed resistance to soil-applied herbicides is a growing concern for agronomic crop production in the U.S. The vast majority of herbicide-resistant weeds reported to date have been studied with foliar, or postemergence, herbicides. Due to the relatively low number of weeds resistant to soil-applied herbicides reported worldwide, particularly in dicot weed species, physiological and molecular mechanisms conferring resistance need to be uncovered and new methods to study resistance to soil-applied herbicides need to be developed.

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.

Our recent research to investigate resistance in waterhemp (*Amaranthus tuberculatus*) to the soil-applied herbicide *S*-metolachlor has led to the development and optimization of several whole-plant and laboratory methods for studying detoxification-based resistance in weeds, as well as a peer-reviewed publication in 2021 (Strom et al. 2021).

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

Our target audiences are corn, sorghum, and soybean growers in the U.S., as well as weed scientists in industry and academia. The methods developed and resulting publication have shed new light on an unexpected mechanism for resistance to *S*-metolachlor in waterhemp, and has set the framework for continued research into weed resistance to soil-applied herbicides.

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

Weed resistance to herbicides is a serious concern for secure and safe food production in the U.S. by limiting crop yield and harvest quality. Understanding resistance mechanisms and traits in problematic weeds such as waterhemp allows weed science and crop protection researchers to target new management strategies to prevent resistant waterhemp from becoming more widespread.

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 to report. Several postdoctoral, graduate, and undergraduate students have worked on the project and have gained valuable research skills and knowledge regarding whole-plant physiology and biochemical enzyme assays in the laboratory. Results and findings of this research have been presented to growers at the UIUC Agronomy Day, weed scientists at the North Central Weed Science Society and Weed Science Society of America annual meetings, and results have been disseminated to the scientific community via the peer-reviewed publication below.

Strom, S.A., Hager, A.G., Concepcion, J.C.T., Davis, A.S., Seiter, N.J., Morris, J.A., Kaundun, S.S. and Riechers, D.E. 2021e Metabolic pathways for *S*-metolachlor detoxification differ between tolerant corn and multiple-resistant waterhemp. Plant and Cell Physiology 62, 1770–1785. DOI: 10.1093/pcp/pcab132.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Weed resistance to herbicides is a serious concern for secure and safe food production in the United States because it limits crop yield and harvest quality. Understanding resistance mechanisms and traits in problematic weeds such as waterhemp allows weed science and crop protection researchers to target new management strategies to prevent resistant waterhemp from becoming more widespread.

DEVELOP ORAL FLUID-BASED BLOCKING ELISA FOR DETECTION OF ASFV INFECTION

Project Director

Ying Fang

Organization

University of Illinois
Accession Number
1024836

DEVELOP ORAL FLUID-BASED BLOCKING ELISA FOR DETECTION OF ASFV INFECTION

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

Recent outbreaks of African Swine Fever virus (ASFV) in China and some European countries pose a potential pandemic threat to the global swine industry. Highly sensitive and specific diagnostic assays are urgently needed for rapid detection and implementation in quarantine and elimination of infected animals. An antibody test is commonly used as a diagnostic tool for detecting host immune response following infection, which is important to determine the prevalence of the viral infection in a population and allow us to identify individual animals who have been infected. Our previous studies demonstrated that the oral-fluid provides a cost effective and non-invasive sample for detection of specific host antibody response. In this study, we developed an oral-fluid based blocking ELISA (bELISA) for detection of ASFV-specific antibody response in immunized/infected pigs.

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 our previous work supported by the National Pork Board, we generated a panel of monoclonal antibodies (mAbs) against eight antigens of ASFV. In this study, we selected an anti-p30 mAb to develop a bELISA for detection of antibody response in oral fluid samples from ASFV-infected or immunized pigs. The oral fluid- based bELISA was shown to be able to detect antibodies at picogram level from crude or impure oral fluid samples. Initial validation using 511 known-negative and 55 known-positive oral fluid samples demonstrated diagnostic sensitivity of 98.2% and specificity of 99.0%, with an optimal cutoff percent inhibition (PI) value of 43.53%. The coefficients of variation is below 10%, which demonstrates the high repeatability of the assay.

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

The standard antibody test for ASF approved by the World Organization for Animal Health is using live virus as an antigen, which involves high containment facilities and select agent permits. To overcome this problem, several antibody tests (mostly tests on serum samples) were developed using recombinant ASFV proteins expressed in *E.coli* or by baculovirus. These assays showed good sensitivity and specificity under the laboratory controlled settings; however, one of the disadvantages continues to be the number of false positive results obtained with field samples. Therefore, a second confirmatory test is required. The bELISA provides the similar level of sensitivity but higher level of specificity when compared with traditional ELISA. In addition, compared to a serum-based test, oral-fluid provides a cost effective and non-invasive alternative to serum samples.

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

The bELISA test developed in this study can be used for rapid detection of ASFV infection. It can be immediately available to ASF surveillance networks and researchers as important tools in a variety of ongoing and future studies. Besides being distributed in the U.S., this test can also be distributed to China, Africa and other European countries to help disease control programs and prevent the virus from spreading to the U.S. They will be important tools in the outbreak surveillance as well as in the recovery phase to provide assurances on the eradication of ASFV.

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

This project provides opportunities for collaboration among researchers from University of Illinois at Urbana-Champaign, Iowa State University and Kansas State University. It establishes research environment for training of graduate students.

Research data have been disseminated by presenting at an annual swine viral disease meeting - North American PRRS/NC229 symposium held on December 4th, 2021 at Chicago, Illinois. We are currently preparing the manuscript for publication in a peer-reviewed journal.

For the next reporting period, we plan to complete the test validation. We will apply this test to a time course study to determine the earliest time point that antibody response can be detected.

Fangfeng Yuan, Vlad Petrovan, Luis Gimenez-Lirola, Jeffrey J. Zimmerman, Raymond R. R. Rowland and Ying Fang. 2021. Development of a Blocking Enzyme-Linked Immunosorbent Assay for Detection of Antibodies Against African Swine Fever Virus. North American PRRS/NC229 Symposium, December 4, 2021, Chicago, Illinois.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Recent outbreaks of African Swine Fever virus in China and some European countries pose a potential pandemic threat to the global swine industry. Highly sensitive and specific diagnostic assays are urgently needed for rapid detection and implementation in quarantine and elimination of infected animals. The bELISA test developed in this study can be used for rapid detection of ASFV infection. It can be immediately available to ASF surveillance networks and researchers as an important tool in a variety of ongoing and future studies. Besides being distributed in the United States, this test can also be distributed to China, Africa and other European countries to help disease control programs and prevent the virus from spreading to the U.S.

Ecology and Management of Arthropods in Corn

Project Director
Nicholas Seiter
Organization
University of Illinois
Accession Number
1023377

Ecology and Management of Arthropods in Corn

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

Arthropod pests of corn cost farmers millions of dollars each year. Key problems in Illinois include the development of Bt resistance in both the western and northern corn rootworms. This project seeks to evaluate corn rootworm control methods, develop improved decision-making procedures for rootworm management, and provide best management practice recommendations to Illinois and U.S. corn farmers.

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 PhD student under my supervision completed the second year of a three-year project to examine the use of corn and pumpkin trap crops to improve control evaluations for western corn rootworm. This information will allow researchers to more efficiently assess Bt traits, insecticides, and other tools for rootworm control. In addition, this student is studying movement behavior of corn rootworm among these different trap crop arrangments.

We participated in a regional corn rootworm trapping network, coordinated by research and Extension personnel at Iowa State University across the north central U.S. and Canada. This network consisted of many members of multi-state Hatch committee NC-246. The objectives of this network over time are to better understand and document: (1) Local areas of high populations of western and northern corn rootworm in a given year; (2) Trends in species composition of the rootworm pest

complex over time, i.e. documenting recent increases in northern corn rootworm densities in the central corn belt; and (3) Providing this information to corn farmers and crop advisors to enable them to make better management decisions on their farms.

In collaboration with NC-246 members Dr. Joseph Spencer (Illinois Natural History Survey) and Dr. Elson Shields (Cornell University), we established long-term plots on the University of Illinois Animal Sciences Farm to examine the persistence and impacts of entomopathogenic nematodes as biological control agents for corn rootworm. Similar experiments have been established throughout the United States.

We participated in a sentinel Bt resistance monitoring network coordinated by Dr. Galen Dively (University of Maryland) and made up primarily by NC-246 members. We collaborated with Dr. Kacie Athey (Specialty Crops Entomologist, University of Illinois) to conduct a trial in Urbana, Illinois. This network provides both a national overview of Bt resistance in the corn earworm and local data on the performance of key Bt proteins locally. We determined that corn earworm populations in central Illinois were highly resistant to all but one (Vip3A) of the Bt proteins commonly used for control of this insect pest.

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

Our ultimate objective in participating in this Hatch project is to deliver accurate, up-to-date information on current and future insect pest management practices to corn farmers and crop advisors in Illinois and the surrounding region. During 2021, we did so in the following ways:

We published a report of applied research for clientele, providing timely information on control efficacy of insecticides and Bt traits for control of corn rootworm and other major insect pests to our Extension clientele. This report (and those from 2018-2020) are available at: https://go.illinois.edu/2021PestPathogenARB.

We presented corn insect management recommendations directly to Extension clientele based in part on research conducted under this Hatch project. In 2021, Dr. Seiter gave presentations at eight webinars and three in-person events to a total audience of 1,531 corn farmers and crop advisors.

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

The broader public benefits from research on insect pest management in corn (and other crops) in two primary ways. While these benefits are mostly indirect to the non-farming public, the economic efficiency and environmental sustainability of the U.S. agricultural enterprise benefit every U.S. resident in some way.

The improved economic efficiency of production when optimal insect management practices are adopted increases yields and lowers input prices, resulting in more affordable food. Activities under this Hatch project both contribute to the development of optimal best management practices for corn producers and encourage adoption (and refinement) of these practices through reciprocal information-sharing with farmers and crop advisors through on-farm demonstrations, presentations, and Extension workshops.

Improved management recommendations discourage the over-use of insect management inputs. Mitigating the over-use of insecticides results in a direct benefit to the general public through the reduction in negative environmental impacts associated with insecticide use (non-target toxicity, accidental contamination, etc). In addition, the public benefits indirectly when less toxic alternatives (such as Bt traited corn hybrids) are used judiciously based on best management practices. While overuse of these tactics does not negatively impact the environment, it does impact their utility by exposing them to unnecesary selection pressure and, ultimately, insect resistance. When tactics such as these lose their utility due to insect resistance development, they typically are replaced by older, more toxic controls such as organophosphate insecticides.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Our ultimate objective is to deliver accurate, up-to-date information on current and future insect pest management practices to corn farmers and crop advisors in Illinois and the surrounding region. In 2021, we published a report of applied research for clientele, providing timely information on control efficacy of insecticides and Bt traits for control of corn rootworm and other major insect pests to our Extension clientele and presented corn insect management recommendations directly to Extension clientele. The broader public benefits from research on insect pest management in corn through improved economic efficiency and environmental sustainability of the United States agricultural industry.

Ecology and Management of Arthropods in Corn

Project Director

Joseph Spencer

Organization

University of Illinois

Accession Number

1023223

Ecology and Management of Arthropods in Corn

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

Corn rootworm beetles including the northern corn rootworm (*Diabrotica barberi*, NCR) and the western corn rootworm (*Diabrotica virgifera virgifera*, WCR) are the most significant pests of the United States' most important and valuable agricultural crop, corn. Preserving the utility of Bt traits as corn rootworm management tools, slowing the evolution and spread of resistance developing effective integrated pest management (IPM) and insect resistance management (IRM) strategies, as well as improving our understanding of corn rootworm genetics, biology, ecology and behavior are all components of this project's goals. Our FFY2021 work was focused on measuring Bt resistance in WCR and NCR populations from around Illinois.

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.

Six Illinois corn rootworm populations (five WCR and one NCR) were evaluated for their resistance to Bt toxins expressed in Bt corn hybrids (i.e. Cry3Bb1 and Cry34/35Ab1) in plant based bioassays. The same populations were also tested on a Bt hybrid that expressed both toxins simultaneously (a “pyramided” hybrid). These six field-collected populations were tested along with a Bt susceptible WCR or NCR obtained from USDA NCARL in Brookings, South Dakota. Results for all field populations indicated that they were resistant to the Cry3Bb1 toxin; their survival on the Cry3Bb1-expressing hybrid was equivalent to their survival on a non-Bt control corn hybrid. All populations also displayed resistance to the Cry34/35Ab1 toxin, though corrected survival data suggest that resistance to Cry34/35Ab1 has not reached the same high level as that of Cry3Bb1. All populations also displayed high survival on the pyramid of both toxins, a result that could be expected based on resistance to the individual toxins. Corrected survival on the pyramided hybrid indicated that there is still some efficacy against Illinois corn rootworm populations. Evidence of resistance to both Bt toxins currently available for corn rootworm management means that Illinois growers should be cautious about relying on Bt corn hybrids to manage high populations. FFY 2021 results suggest that Bt resistance in Illinois NCR and WCR is continuing to increase. Where possible, cornfields should be rotated to soybean. Use of soil applied insecticide on non-Bt corn hybrids is an option to protect corn roots where economic populations are expected.

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

This information was shared with Illinois growers, crop consultants and seed industry professionals via presentations and printed materials. Findings were shared to allow growers to make better informed decisions about the expected efficacy of Bt corn hybrids that will factor in to seed purchasing decisions for 2022 growing season.

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

Sharing information about diminished Bt corn hybrid efficacy along with recommendations to mitigate potential losses due to poorly-anticipated rootworm larval injury can reduce reactionary use of insecticides following discovery of unexpected injury.

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 problems were encountered. Two University of Illinois students were supported (in part) on project funds. Results from the FFY 2021 project were shared with the public during the University of Illinois' Agronomy Day event in late August, as well as in written materials disseminated as a report published online in the early winter. A similar report of the FFY 2020 findings were shared early in 2021. The project will continue in 2022 with bioassays of five more populations collected in 2021 and collection of new populations in 2022. The rootworm populations to be collected in 2020 will aim to include more NCR populations and to also collect WCR from more counties that have not previously been sampled.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Corn rootworm beetles including the northern corn rootworm (*Diabrotica barberi*, NCR) and the western corn rootworm (*Diabrotica virgifera virgifera*, WCR) are the most significant pests of the United States' most important and valuable agricultural crop, corn. Preserving the utility of Bt traits as corn rootworm management tools, slowing the evolution and spread of resistance developing effective integrated pest management (IPM) and insect resistance management (IRM) strategies, as well as improving our understanding of corn rootworm genetics, biology, ecology and behavior are all components of this project's goals. Results from this project are shared with Illinois growers, crop consultants, and seed industry professionals, allowing them to make better informed decisions about the expected efficacy of Bt corn hybrids that will factor in to seed purchasing decisions for the 2022 growing season.

Food: Maintain a safe and accessible food supply

Project Director
Elizabeth Welbes
Organization
University of Illinois
Accession Number
7001937

Certified Food Protection Managers take essential steps to protect patrons they serve

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

A 2015 study estimated that foodborne illness represents an annual burden to society of approximately $36 billion, with an average cost of $3,630 per illness. In a 2013 study, where a single cause was identified for restaurant-associated foodborne disease outbreaks, 34% of outbreaks were associated with practices within the establishment. Illinois regulations require cottage food operators, retail food establishments, and facilities that serve food to have at least one Certified Food Protection Manager (CFPM) on staff. Local public health inspectors monitor this regulation. This important legislative requirement creates a need for access to ongoing training for employees in the food industry in order to secure and retain employment.

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.

Extension educators on the nutrition and wellness team conducted 28 **Certified Food Protection Manager (CFPM)** training courses in 2021 with 291 participants. Participants learn about principles and recommendations of the FDA Food Code focused on food safety and contamination, employee health and hygiene, safe food handling practices, cleaning and sanitizing, and Hazard Analysis Critical Control Point systems. This program is an American National Standards Institute (ANSI) accredited course, which meets the Illinois Department of Public Health's Food Service Sanitation Code requirements.

The eight-hour course prepares food managers with knowledge competencies sufficient to pass the National Registry of Food Safety Professionals exam with a passing score of 75% or higher. The exam is proctored by Illinois Extension educators in conjunction with tthe CFPM course.

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

Records indicate that 149 participants elected to take the CFPM exam through Extension proctors. Among those who tested, 86% achieved a passing score, with an average score of 91 out of 100. A post-program evaluation, completed by 105 program participants, assessed self-reported changes in knowledge and ability to reduce food hazards. A majority (80%) reported improved knowledge of foodborne illness risks associated with improper food handling and more than 7 out of 10 participants felt more capable of reducing food safety hazards in their environment and felt more able to use correct temperature controls, a critically important requirement for improving food safety. Overall 86% reported knowledge change in one or more food safety topics covered and 80% reported improved ability to implement effective food protection practices. Intent to implement one or more food safety actions was shared by 75 (71%) of respondents with the most common action to more carefully monitor temperatures when thawing, cooking, and storing perishable food products. Sanitation best practices, such as proper handwashing techniques and sanitizing protocols were also frequently reported intended actions. Additionally, 99% of respondents indicated they were “very likely” or “extremely likely” to share food safety knowledge gained with others.

A 6-month follow-up survey demonstrated that there was strong alignment between intentions and actual implementation of food safety practices among the 28 respondents. Respondents reported that:

- 92% shared food safety knowledge with an average of 6 other people
- 89% implemented at least one recommended food safety practice
- 86% improved handwashing techniques
- 82% improved control of food temperatures

Based on Bureau of Labor Statistics 2020 data for Illinois, food service managers earn an average annual salary of $53,090 per year. Extrapolating this average pay to 129 CFPM training participants who passed the National Registry of Food Safety Professionals certification exam following CFPM training, Extension is helping to support retention of over $6.8 million in combined annual pay for CFPM by providing training and testing that enabled food managers to meet this job-essential certification requirement.

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

Public benefits are clear when Certified Food Protection Managers implement best practices in their facilities and establishments. Reduction in risks and costs of food-borne illness will extend to the many thousands of residents who eat in safer Illinois food service environments.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Illinois regulations require cottage food operators, retail food establishments, and facilities that serve food to have at least one Certified Food Protection Manager (CFPM) on staff. This important legislative requirement creates a need for access to ongoing training for employees in the food industry in order to secure and retain employment. Extension educators on the nutrition and wellness team conducted 28 Certified Food Protection Manager (CFPM) training courses in 2021 with 291 participants. A majority (80%) reported improved knowledge of food borne illness risks associated with improper food handling and more than 7 out of 10 participants felt more capable of reducing food safety hazards in their environment and more able to use correct temperature controls, a critically important requirement for improving food safety. A 6-month follow-up survey demonstrated that there was strong alignment between intentions and actual implementation of food safety practices. Based on Bureau of Labor Statistics 2020 data for Illinois, food service managers earn an average annual salary of

$53,090 per year. Extrapolating this average salary to the 129 CFPM training participants who passed the National Registry of Food Safety Professionals certification exam following CFPM training, Extension is helping to support retention of over $6.8 million in combined annual pay for CFPM by providing training and testing that enabled food managers to meet this job-essential certification requirement. Reduction in risks and costs of food-borne illness will extend to the many thousands of residents who eat in safer Illinois food service environments due to competent Certified Food Protection Managers trained by Illinois Extension.

Closing Out (end date 09/07/2023)

LONG-TERM SELECTION OF CORN FOR OIL AND PROTEIN CONTENT

Project Director

Stephen Moose

Organization

University of Illinois

Accession Number

1019279

LONG-TERM SELECTION OF CORN FOR OIL AND PROTEIN CONTENT

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

The Illinois Long Term Selection experiment has conducted more than five hundred cycles of artificial selection for seed composition traits, creating a wide range of variation for concentrations of starch, protein, and oil. The genetic basis for these dramatic changes is not known. This projects aims to discover genes that contribute to the selection responses, which will not only inform evolutionary theory, but also may inform breeding strategies to enhance nutritional content of corn and other cereal grains.

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.

1. An additional cycle of selection was conducted for each of the Illinois High Protein (30.3% protein), Illinois Reverse Low Protein (17% protein), Illinois Reverse High Protein3 (16.4%), Illinois Reverse High Protein2 (11.4%), and Illinois Reverse Low Protein2 (6.7%).

2. A sixth generation of backcrossing was conducted to create populations of near-isogenic lines among the different Illinois Protein Strains, as a resource that will facilitate future fine-mapping and functional validation of genes contributing to the variation in grain protein concentration. For each population, the recurrent parent is a near-isogenic line that carries the FLOURY2-RFP (FL2-RFP) transgene, which is an easily scored visual marker for seed protein accumulation. From each BC5 family grown in 2021, 5 BC6 ears were produced. Grain protein concentration was measured for each ear using near-infrared reflectance.

3. Interest from a local brewer has prompted an evaluation of hybrids produced by crossing inbred lines derived from the Illinois Low Oil and Illinois Low Protein populations. The hybrids yielded approximately one hundred bushels per acre and 2-3% oil, but suffered from severe lodging and slow dry-down.

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

The creation of near-isogenic lines will enable focused studies on the contributions of small regions of the genome on seed protein concentration, which will make it easier to track down the genes that control these traits. Furthermore, the low oil by low protein hybrids were successfully used in beer production, under license from the University of Illinois.

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

The knowledge generated by the project stimulates interest in the genetic materials produced for existing and new applications. This interest translates into requests for seeds and biological materials from the Illinois Long Term Selection experiment.

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 provides practical training to undergraduate and graduate students in the genetic improvement of corn, specifically grain composition and related traits, such as nitrogen utilization. A journal article was published in Nature Communications that used the Illinois High Protein1 and Illinois Low Protein1 inbred lines, as well as hybrids using these parents, in a project to predict variation in nitrogen use efficiency using models derived from gene expression data. The citation is:

Cheng, C.-Y., Li, Y., Varala, K., Huang, J., Kim, G.J., Halim, J., Arp, J., Bubert, J., Chih, H.-J. S., Levinson, G.L., Park, S. H., Cho, H. Y., **Moose, S.P**. and Coruzzi, G.M. 2021. Evolutionarily informed machine learning enhances the power of predictive gene-to-phenotype relationships. *Nature Communications* 12: 5627, https://doi.org/10.1038/s41467-021-25893-w.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The Illinois Long Term Selection experiment has conducted more than five hundred cycles of artificial selection for seed composition traits, creating a wide range of variation for concentrations of starch, protein, and oil. This project seeks to discover genes that contribute to selection responses, which will not only inform evolutionary theory, but also may inform breeding strategies to enhance nutritional content of corn and other cereal grains. The creation of near-isogenic lines will enable focused studies on the contributions of small regions of the genome on seed protein concentration, which will make it easier to identify the genes that control these traits. Furthermore, the low oil by low protein hybrids were successfully used in beer production, under license from the University of Illinois.

LONG-TERM SELECTION OF CORN FOR OIL AND PROTEIN CONTENT

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

The Illinois Long Term Selection experiment has conducted more than five hundred cycles of artificial selection for seed composition traits, creating a wide range of variation for concentrations of starch, protein, and oil. The genetic basis for these dramatic changes is not known. This project aims to discover genes that contribute to the selection responses, which will not only inform evolutionary theory, but also may inform breeding strategies to enhance nutritional content of corn and other cereal grains.

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.

1. An additional cycle of selection was conducted for each of the Illinois High Protein (30.3% protein), Illinois Reverse Low Protein (17% protein), Illinois Reverse High Protein3 (16.4%), Illinois Reverse High Protein2 (11.4%), and Illinois Reverse Low Protein2 (6.7%).

2. A sixth generation of backcrossing was conducted to create populations of near-isogenic lines among the different Illinois Protein Strains, as a resource that will facilitate future fine-mapping and functional validation of genes contributing to the variation in grain protein concentration. For each population, the recurrent parent is a near-isogenic line that carries the FLOURY2-RFP (FL2-RFP) transgene, which is an easily scored visual marker for seed protein accumulation. From each BC5 family grown in 2021, 5 BC6 ears were produced. Grain protein concentration was measured for each ear using near-infrared reflectance.

3. Interest from a local brewer has prompted an evaluation of hybrids produced by crossing inbred lines derived from the Illinois Low Oil and Illinois Low Protein populations. The hybrids yielded approximately one hundred bushels per acre and 2-3% oil, but suffered from severe lodging and slow dry-down.

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

The creation of near-isogenic lines will enable focused studies on the contributions of small regions of the genome on seed protein concentration, which will make it easier to track down the genes that control these traits. Furthermore, the low oil by low protein hybrids were successfully used in beer production, under license from the University of Illinois.

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

The knowledge generated by the project stimulates interest in the genetic materials produced for existing and new applications. This interest translates into requests for seeds and biological materials from the Illinois Long Term Selection experiment.

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 provides practical training to undergraduate and graduate students in the genetic improvement of corn, specifically grain composition and related traits, such as nitrogen utilization. A journal article was published in Nature Communications that used the Illinois High Protein1 and Illinois Low Protein1 inbred lines, as well as hybrids using these parents, in a project to predict variation in nitrogen use efficiency using models derived from gene expression data. The citation is:

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Impact Statement (Optional)

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Closing Out (end date 09/07/2023)

IMPROVING THE SAFETY AND QUALITY OF FOODS THROUGH ENGINEERING TECHNOLOGIES

Project Director

Yi-Cheng Wang

Organization

University of Illinois

Accession Number
1018471

IMPROVING THE SAFETY AND QUALITY OF FOODS THROUGH ENGINEERING TECHNOLOGIES

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

Food safety is a constant concern in the United States, where 48 million get sick and 3,000 die annually due to various types of foodborne contaminants. Moreover, longstanding needs to ensure the quality and safety of food are becoming increasingly urgent, due to an increasingly complex global food-supply system.

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.

To address the issue noted above, this project is developing engineering technologies to improve the safety and quality of food products. Specifically, the three objectives of this development activity are to create: 1) New technologies for the rapid diagnosis of foodborne contaminants, 2) Novel packaging types, and 3) Other new technologies for improving food safety, quality, and security.

Working towards Objective 1, we have conducted a literature review, and designed and evaluated components that can recognize specific foodborne pathogens.

For Objective 2, we have developed a biodegradable film that includes pH-sensitive natural pigments extracted from plants, and which changes color when pH changes occur. Because spoilage of many food products can lead to pH variation, these films have immense real-world potential as visual indicators of food products' quality. By empowering consumers to make more accurate decisions about when to discard or consume the food products using intelligent packaging, they would ultimately reduce the proportion of U.S. food that is thrown away.

Lastly, in pursuit of Objective 3, we have designed and built a light-based system for inactivating foodborne pathogens, and evaluated its performance. This experience, and the preliminary data we gathered during it, were incorporated into a USDA-NIFA grant proposal submitted in FY 2021 which was successful. The grant funds received will enable us to look deeper into both the mechanisms, and the potential real-world food-safety applications, of light-based bacteria-inactivation systems.

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

The knowledge gained from this project's activities is expected to boost fundamental understanding of how to integrate engineering principles with food science, microbiology, chemistry, physics, and materials science to address food-related and agriculture-related issues. As such, it is likely to benefit a target audience including, but not limited to, graduate and undergraduate students; scientists and engineers working in peer academic institutions; government regulatory agencies; and farmers and the wider food industry.

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

The outcomes of this project's activities are likely to include user-friendly new technologies for monitoring the quality and safety of food products and for inactivating pathogens. By potentially better-informing people about when food is unsafe, the project's outcomes could ultimately benefit public health. In addition, project outcomes including intelligent packaging could allow consumers to avoid throwing away food that is still good to consume, thus saving them money and reducing stress on the natural environment.

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

Regarding training, two graduate students have been supported during their master's studies. As for dissemination, the results have been presented through the following conferences presentations:

Lei, Y., Yao, Q. and Wang, Y.-C., 2021. Intelligent packaging films for food-freshness monitoring made from guar gum, locust bean gum, and anthocyanin extracted from red cabbage. Institute of Food Technologists (IFT) annual meeting, July 19-21, 2021.

Lei, Y., Yao, Q., Jin, Z. and Wang, Y.-C., 202.1 Intelligent films for shrimp-freshness monitoring based on pectin, sodium alginate, cellulose nanocrystals, and red cabbage extracts. American Chemical Society Fall 2021, August 22-26, 2021.

We will continue to work on the fabrication of sensors (Objective 1), on investigations of various polymers' suitability for intelligent packaging applications (Objective 2), and on developing novel engineering approaches to improve food quality and safety (Objective 3).

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Food safety is a constant concern in the United States, where 48 million get sick and 3,000 die annually due to various types of foodborne contaminants. Our goal is to boost our fundamental understanding of how to integrate engineering principles with food science, microbiology, chemistry, physics, and materials science to address food-related and agriculture-related issues. For example, we have developed a biodegradable film that includes pH-sensitive natural pigments extracted from plants, and which changes color when pH changes occur. Because spoilage of many food products can lead to pH variation, these films have immense real-world potential as visual indicators of food products' quality. By empowering consumers to make more accurate decisions about when to discard or consume the food products using intelligent packaging, they would ultimately reduce the proportion of food waste.

QUANTIFYING THE OCCURENCE OF HERBICIDE-RESISTANT WEEDS IN ILLINOIS AGRONOMIC CROPS

Project Director
Aaron Hager
Organization
University of Illinois
Accession Number
1014072

QUANTIFYING THE OCCURENCE OF HERBICIDE-RESISTANT WEEDS IN ILLINOIS AGRONOMIC CROPS

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

The evolution of herbicide-resistant weed populations represents a serious challenge to the successful production of agronomic crops. Weeds continue to evolve mechanisms of resistance to herbicides that are critical tools for crop production. Our research attempts to understand resistance mechanisms not caused by changes in the herbicide target site.

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.

Two Illinois waterhemp (*Amaranthus tuberculatus*) populations (CHR, MCR) are resistant to very-long-chain fatty acid (VLCFA)-inhibiting herbicides. The mechanism of resistance to the VLCFA-inhibitor, *S*-metolachlor, is enhanced metabolism compared with sensitive populations. Moreover, CHR and SIR metabolized *S*-metolachlor at the same rate as corn, which is naturally tolerant due to glutathione *S*-transferase (GST)-mediated metabolism. Experiments were designed to expand upon previous findings and directly investigate the metabolic enzymes involved in *S*-metolachlor resistance. GST assays compared specific activities from CHR, SIR, a sensitive waterhemp population (WUS), and corn utilizing radiolabeled *S*-metolachlor as a substrate. Specific activities for CHR and SIR were 1.7–2.0 fold greater than WUS, respectively. Corn, however, possessed 2.6–

3.0 fold greater GST activity than resistant waterhemp. P450 activity assays using waterhemp and corn microsomes were developed since CHR and SIR seedlings metabolize *S*-metolachlor as rapidly as corn, but do not have comparable GST activity. Microsomes from CHR and SIR possessed 21–28 fold greater specific activity than WUS using radiolabeled *S*-metolachlor as a substrate. CHR and SIR microsomes oxidized *S*-metolachlor 30–39 fold more efficiently than corn and formed a single metabolite, later identified as *O*-demethylated *S*-metolachlor via co-chromatography with an authentic standard and liquid chromatography-mass spectrometry. Results demonstrate CHR and SIR have enhanced GST activity and greater *S*-metolachlor *O*-demethylation activity than WUS or corn.

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

This research demonstrates how waterhemp has evolved mechanisms of resistance to VLCFA-inhibiting herbicides that are similar to the natural tolerance mechanisms of corn. These results are an important step toward understanding how these resistance mechanisms have evolved; i.e., can we learn what caused the evolution of these mechanisms so we can better develop recommendations for improved management of existing herbicide-resistant populations and that slow the evolution of similar/dissimilar mechanisms.

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

This research advances our understanding of metabolic herbicide resistance mechanisms in waterhemp, widely considered to be the most problematic dicot weed species across much of the Midwest. These and future advances will help us develop improved management recommendations that reduce the selection intensity for the evolution of resistance mechanisms. This will result in improved weed control in corn and soybean, resulting in improved grain yield and a stable food supply for the general public.

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 significant changes or problems were encountered with this research. Results have been (and continue to be) disseminated via myriad outlets, including presentations at scientific society meetings, field tours, Extension meetings, and agriculture print and radio media. Future research will address the recent evolution of dicamba resistance in Amaranthus tuberculatus in Illinois.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The evolution of herbicide-resistant weed populations represents a serious challenge to the successful production of agronomic crops. This research advances our understanding of metabolic herbicide resistance mechanisms in waterhemp, widely considered to be the most problematic dicot weed species across much of the Midwest. These and future advances will help us to develop improved management recommendations that reduce the selection intensity for the evolution of resistance mechanisms. This will result in improved weed control in corn and soybean, resulting in improved grain yield and a stable food supply.

MOLECULAR AND GENETIC CHARACTERIZATION OF XANTHOMONAS SPECIES THAT CAUSE BACTERIAL SPOT DISEASE ON VEGETABLE CROP PLANTS IN ILLINOIS

Project Director
Sarah Hind
Organization
University of Illinois
Accession Number
1014857

MOLECULAR AND GENETIC CHARACTERIZATION OF XANTHOMONAS SPECIES THAT CAUSE BACTERIAL SPOT DISEASE ON THE SOLANACEAE AND CUCURBITACEAE FAMILIES OF VEGETABLE CROPS IN ILLINOIS

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

Bacterial spot diseases caused by *Xanthomonas* species negatively impact crop production in the United States, specifically in vegetable crops including tomato, pepper, pumpkin, and squash. More work is needed to better understand pathogen virulence determinants and to identify genetic sources of host resistance, particularly in cucurbit plants.

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 characterized the motility of *Xanthomonas* strains pathogenic to tomato and demonstrated how motility could impact the virulence of these bacteria (see Article #8 in the Comments section). Additionally, we observed that many of the strains isolated from Illinois tomato production fields are resistant to copper treatments, which impacts our management recommendations for Illinois farmers (see Article #1). We also characterized *Xanthomonas* strains pathogenic to pumpkin and winter squash, and identified potential genetic sources of host resistance that we plan to follow up on in future research (see Articles #2-7).

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

Our research has direct impacts on management recommendations we provide to vegetable growers in Illinois. By identifying the location and prevalence of copper-resistant pathogens, we can advise farmers about their use of copper-based sprays for managing bacterial spot disease. Additionally, by identifying factors and conditions under which bacterial spot disease is more prevalent, we can recommend strategies that growers can follow to mitigate the impacts of the disease. My students and I presented our findings at relevant scientific venues (local research days and symposia), where other scientists benefitted from increased understanding about these pathogens.

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

The broader public has benefitted from increased awareness of the importance of disease management for vegetable production in Illinois specifically, and in the United States more generally. We have disseminated our research findings to the public via our college news organization (Voices of ACES Article on November 25, 2020, https://aces.illinois.edu/blog/pumpkinproject-gives-student-greenhouse-experience; ACES News Article on March 24, 2021, https://aces.illinois.edu/news/genomesequenced-pesky-pumpkin-pathogen). Also, I discussed our research findings with groups of high school and university students virtually visiting our laboratory and department.

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.

Problems Encountered:

Research productivity and conference/travel participation continued to be negatively impacted by the COVID-19 pandemic.

Training Opportunities:

Two doctoral graduate students completed projects that were included in their dissertations, graduated (August and December 2021), and started postdoctoral research positions. Four journal articles resulted from these research projects (see Articles #4, 5, 6, and 8 in the comments section). Ten undergraduate students were trained by myself, with the assistance of one graduate student. All students participated in weekly group meetings, which included individual presentations of their research as well as readings and discussions of primary literature articles related to our field of study. Every undergraduate student also submitted a research report at the end of each semester. Two undergraduate students presented their research results on posters during a local undergraduate research day.

Accepted/Published Journal Articles:

1. Khanal S, **Hind SR**, and Babadoost M. (2020) Occurrence of Copper-Resistant *Xanthomonas perforans* and *X. gardneri* in Illinois Tomato Fields. *Plant Health Progress* 21(4): 338-344. DOI: 10.1094/PHP-06-20-0048-RS.

2. Khanal S, **Hind SR**, and Babadoost M. (2020) Occurrence of bacterial spot in Illinois tomato fields and characteristics of the causal agents. *HortScience* 56(1): 8-12. DOI: 10.21273/HORTSCI15215-20.

3. Rai R, Pasion J, Majumdar T, Green CE, and **Hind SR**. (2021) Genome sequencing and functional characterization of *Xanthomonas cucurbitae*, the causal agent of bacterial spot disease of cucurbits. *Phytopathology* 111(8): 1289-1300. DOI: 10.1094/PHYTO-06-20-0228-R.

4. Sulley S, Babadoost M, and **Hind SR**. (2021) Biocontrol agents from cucurbit plants infected with *Xanthomonas cucurbitae* for managing bacterial spot of pumpkin. *Biological Control* 163:104757. DOI: 10.1016/j.biocontrol.2021.104757.

5. Sulley S, Huang Y, **Hind SR**, and Babadoost M. (2021) Screening and identification of *Cucurbita* germplasm resistant to *Xanthomonas cucurbitae*, incitant of cucurbit bacterial spot. *Plant Pathology* 70(9): 2188-2196. DOI: 10.1111/ppa.13445.

6. Sulley S, **Hind SR**, and Babadoost M. (2021) Survival of *Xanthomonas cucurbitae* in different cropping rotations, plant debris, and weeds in pumpkin fields. *Plant Health Progress* 22(4): 529-535. DOI: 10.1094/PHP-03-21-0069-RS.

Submitted/In Revision Articles:

1. Pasion J and **Hind SR**. Utilizing Tajima's D to identify potential microbe-associated molecular patterns in *Xanthomonas euvesicatoria* and *X. perforans*. *Physiological and Molecular Plant Pathology* 116: 101744. DOI: 10.1016/j.pmpp.2021.101744.

2. Malvino M, Bott AJ, Green CE, Majumdar T, and **Hind SR**. Influence of flagelling polymorphisms, gene regulation, and responsive memory on the motility of *Xanthomonas* species that cause bacterial spot disease of solanaceous plants. *Molecular Plant-Microbe Interactions*. DOI: 10.1094/MPMI-08-21-0211-R.

Impact Statement (Optional)

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Bacterial spot diseases caused by *Xanthomonas* species negatively impact crop production in the United States, specifically in vegetable crops including tomato, pepper, pumpkin, and squash. This project improves our understanding of pathogen virulence determinants and helps us to identify genetic sources of host resistance, particularly in cucurbit plants. Our research directly impacts management recommendations we provide to vegetable growers in Illinois. By identifying the location and prevalence of copper-resistant pathogens, we can advise farmers about their use of copper-based sprays for managing bacterial spot disease.

SOYBEAN BREEDING AND GENETICS

Project Director
Brian Diers
Organization
University of Illinois
Accession Number
1015014

SOYBEAN BREEDING AND GENETICS

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

There is a need for new soybean varieties as demand for the crop is increasing and farmers face new disease and pest pressure and inconsistent growing environments resulting from climate change. This project is focused on developing new, high yielding soybean varieties for farmers that will help increase their profitability.

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.

Soybean production efficiency needs to be improved as global demand for the crop continues to increase. Because production environments vary across the country, there is a need for soybean breeding efforts throughout the soybean growing region. The University of Illinois soybean breeding program is focused on developing high yielding non-GMO varieties with improved oil quality and enhanced disease and pest resistance. During the past year, new experimental lines were developed using traditional and marker-assisted selection to identify lines with resistance and high-quality oil. Lines with these traits were evaluated in yield tests and the best experimental lines were selected. During 2021, the program grew over 11,000 observation plots and over 11,700 yield plots. Based on results from 2021 field tests and tests during previous years, eleven new non-GMO varieties were licensed to a seed company. In addition, we are in the process of licensing six new non-GMO varieties with altered fatty acid content. These varieties have oleic acid levels greater than 80% and linolenic levels below 3%. This change enhances the functionally of the oil and should increase the market for soybean oil.

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

The target audience of the project is soybean farmers in Illinois and the surrounding region. They benefit from the varieties released from this project and the knowledge gained through research. The varieties that are being released can directly help these farmers as there is growing interest in producing non-GMO soybean varieties as they can often be paid a premium for this production. Private companies have not been emphasizing this non-GMO market as they are mostly focused on GMO varieties. Therefore, university programs are important for providing varieties for this market. Additionally, our work on developing varieties with high oleic acid and low linolenic acid oil can give farmers greater premiums. The altered fatty acids can also increase the market demand for soybean oil and thereby improve soybean prices.

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

There is growing demand for soybean and to fill this demand, higher yielding varieties are needed. Consumers want to have choices and many prefer non-GMO foods and our program is working on developing varieties for this market so such varieties will be more available to growers and in the end, consumers. In addition, there is a need for healthier oils in diets and our efforts in improving oil quality could help impact these diets.

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.

Cerritos-Garcia, D.G., J.P. Granda, R. Matthiessen, B.W. Diers, A.E. Robertson, and S.X. Mideros. 2021. Effect of resistance and ethaboxam seed treatment on the management of Phytophthora root rot in Illinois and Iowa. Plant Health Progress. 22:58-65. https://doi.org/10.1094/PHP-08-20-0068-RS

Meinhardt, C., A. Howland, M. Ellersieck, A. Scaboo, B. Diers, and M. Mitchum. 2021. Resistance gene pyramiding and rotation to combat widespread soybean cyst nematode virulence. Plant Disease. https://doi.org/10.1094/PDIS-12-20-2556-RE.

Shook, J.M., J. Zhang, S.E. Jones, A. Singh, B.W. Diers, and A.K. Singh. 2021. Meta-GWAS for quantitative trait loci identification in soybean. G3. https://doi.org/10.1093/g3journal/jkab117.

Guillermo S.M., N.F. Martin, B.W. Diers, M.F. Santos, E.P. Leles, G. Chigeza, J.H. Francischini. 2021. Development of a generalized additive model (GAM) for soybean maturity prediction in African environments. Agronomy. 11:1043. https://doi.org/10.3390/agronomy11061043.

Butler, K.J., C. Fliege, R. Zapotocny, B. Diers, M. Hudson, and A.F. Bent. 2021. Soybean cyst nematode resistance quantitative trait locus cqSCN-006 alters the regulation of a γ–SNAP protein. MPMI 34:1433-1445.

Impact Statement (Optional)

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There is growing demand for soybean and to fill this demand, higher yielding varieties are needed. Consumers want to have choices and many prefer non-GMO foods and our program is working on developing varieties for this market so such varieties will be more available to growers and in the end, consumers. In addition, there is a need for healthier oils in diets and our efforts in improving oil quality could help impact these diets.

SOYBEAN BREEDING AND GENETICS

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

There is a need for new soybean varieties as demand for the crop is increasing and farmers face new disease and pest pressure and inconsistent growing environments resulting from climate change. This project is focused on developing new, high yielding soybean varieties for farmers that will help increase their profitability.

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.

Soybean production efficiency needs to be improved as global demand for the crop continues to increase. Because production environments vary across the country, there is a need for soybean breeding efforts throughout the soybean growing region. The University of Illinois soybean breeding program is focused on developing high yielding non-GMO varieties with improved oil quality and enhanced disease and pest resistance. During the past year, new experimental lines were developed using traditional and marker-assisted selection to identify lines with resistance and high-quality oil. Lines with these traits were evaluated in yield tests and the best experimental lines were selected. During 2021, the program grew over 11,000 observation plots and over 11,700 yield plots. Based on results from 2021 field tests and tests during previous years, eleven new non-GMO varieties were licensed to a seed company. In addition, we are in the process of licensing six new non-GMO varieties with altered fatty acid content. These varieties have oleic acid levels greater than 80% and linolenic levels below 3%. This change enhances the functionally of the oil and should increase the market for soybean oil.

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

The target audience of the project is soybean farmers in Illinois and the surrounding region. They benefit from the varieties released from this project and the knowledge gained through research. The varieties that are being released can directly help these farmers as there is growing interest in producing non-GMO soybean varieties as they can often be paid a premium for this production. Private companies have not been emphasizing this non-GMO market as they are mostly focused on GMO

varieties. Therefore, university programs are important for providing varieties for this market. Additionally, our work on developing varieties with high oleic acid and low linolenic acid oil can give farmers greater premiums. The altered fatty acids can also increase the market demand for soybean oil and thereby improve soybean prices.

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

There is growing demand for soybean and to fill this demand, higher yielding varieties are needed. Consumers want to have choices and many prefer non-GMO foods and our program is working on developing varieties for this market so such varieties will be more available to growers and in the end, consumers. In addition, there is a need for healthier oils in diets and our efforts in improving oil quality could help impact these diets.

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.

Cerritos-Garcia, D.G., J.P. Granda, R. Matthiessen, B.W. Diers, A.E. Robertson, and S.X. Mideros. 2021. Effect of resistance and ethaboxam seed treatment on the management of Phytophthora root rot in Illinois and Iowa. Plant Health Progress. 22:58-65. https://doi.org/10.1094/PHP-08-20-0068-RS

Meinhardt, C., A. Howland, M. Ellersieck, A. Scaboo, B. Diers, and M. Mitchum. 2021. Resistance gene pyramiding and rotation to combat widespread soybean cyst nematode virulence. Plant Disease. https://doi.org/10.1094/PDIS-12-20-2556-RE.

Shook, J.M., J. Zhang, S.E. Jones, A. Singh, B.W. Diers, and A.K. Singh. 2021. Meta-GWAS for quantitative trait loci identification in soybean. G3. https://doi.org/10.1093/g3journal/jkab117.

Guillermo S.M., N.F. Martin, B.W. Diers, M.F. Santos, E.P. Leles, G. Chigeza, J.H. Francischini. 2021. Development of a generalized additive model (GAM) for soybean maturity prediction in African environments. Agronomy. 11:1043. https://doi.org/10.3390/agronomy11061043.

Butler, K.J., C. Fliege, R. Zapotocny, B. Diers, M. Hudson, and A.F. Bent. 2021. Soybean cyst nematode resistance quantitative trait locus cqSCN-006 alters the regulation of a γ–SNAP protein. MPMI 34:1433-1445.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

There is growing demand for soybean and to fill this demand, higher yielding varieties are needed. Consumers want to have choices and many prefer non-GMO foods and our program is working on developing varieties for this market so that such varieties will be more available to growers and in the end, consumers. In addition, there is a need for healthier oils in diets and our efforts at improving oil quality could help impact these diets. Soybean farmers will benefit as there is growing interest in producing non-GMO soybean varieties as they can often be paid a premium for this production. Private companies have not been emphasizing this non-GMO market as they are mostly focused on GMO varieties. Therefore, university programs are important for providing varieties for this market.

Conservation, Management, Enhancement and Utilization of Plant Genetic Resources

Project Director

J Juvik

Organization

University of Illinois

Accession Number
1014356

Conservation, Management, Enhancement and Utilization of Plant Genetic Resources

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

This program involves research on the biochemistry and genetics controlling biosynthesis and hydrolysis of health-promoting secondary plant compounds found in brassica vegetables and in corn. Consumption of brassica vegetables abundant in these phytochemicals (glucosinolates and certain flavonoids) has been associated with reduced incidence of certain forms of cancer and cardiovascular disease. We also conduct a major project to determine the economic feasibility of extracting red and orange pigments (anthocyanins) from the pericarp and aleurone of maize kernels as natural colorants for processed foods and beverages and potentially for the development of health-promoting anthocyanin-rich pharmaceutical products. These natural alternatives to artificial colors are preferred by consumers and by the processing industry for purposes of product labelling.

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 studied and identified sources of promising germplasm and identified and mapped key genes associated with biosynthesis of health promoting phytochemicals in brassica vegetables and natural colorants in maize. This information has been applied in our breeding programs to develop commercial germplasm with improved nutritional value and as sources of natural colorants.

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

We have been conducting a breeding program to develop improved broccoli cultivars with enhanced nutritional value for commercial release. A breeding program initiated in 2014 for the development of corn hybrids with anthocyanin-rich kernel pericarp is moving toward commercialization. Several companies have provided support for the development of this germplasm and its commercial release as specialty crops. Published information and presentations have been shared with other plant scientists and plant breeders.

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

Ultimately our improved cultivars will be made available to provide cheap sources of natural colors to processed foods and beverages and as dietary or pharmaceutical products with enhanced nutritional value and health promotion.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

We have been conducting a breeding program to develop improved broccoli cultivars with enhanced nutritional value for commercial release. A breeding program initiated in 2014 for the development of corn hybrids with anthocyanin-rich kernel pericarp is moving toward commercialization. Several companies have provided support for the development of this germplasm and its commercial release as specialty crops. Published information and presentations have been shared with other plant scientists and plant breeders. Ultimately our improved cultivars will be made available to provide cheaper sources of natural colors for processed foods and beverages and as dietary or pharmaceutical products with enhanced nutritional value and health promotion.

ECONOMICS OF TECHNICAL AND ENVIRONMENTAL CHANGE IN THE INTERNATIONAL FOOD SYSTEM

Project Director
Alex Winter-Nelson
Organization
University of Illinois

Accession Number
1014548

ECONOMICS OF TECHNICAL AND ENVIRONMENTAL CHANGE IN THE INTERNATIONAL FOOD SYSTEM

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

Work under this project will measure the impact on economic and environmental outcomes of new technologies in the food and agricultural system. The research pays particular attention to the applications of modern data sciences to address issues including but not limited to nitrogen management, water management, climate resilience, crop breeding, and post farm logistics.

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 has made significant development in Data Intensive Farm Management (DIFM) database and software, which involved work with Oracle company to develop a database infrastructure for on-farm precision experimentation. DFIM is conducting 350 large-scale on-farm agronomic field trials in ten U.S. states and creating a cyber-infrastructure that will allow automation of trial design and analysis, with the purpose of expanding on-farm experimentation to tens of thousands of farms per year. DIFM is working with international collaborators to plan and run field trials in Brazil, Canada, South Africa, and Ukraine. This work will provide information to optimize input use with consideration of economic and environmental objectives.

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

This project contributed to increased farm income by facilitating movement of data and valuable management information between farmers and researchers that will assist farmers in making site-specific farm input management decisions. Specific products that benefit agricultural producers and farm managers include:

Information on the Data Intensive Farm Management Project. Project website. difm-cig.org.

On-Farm Experimentation Precision Generator. trialdesign.difm-cig.org/home.

Digital Agriculture Training Workshop: Managing Inputs Using On-farm Data. Workshop funded by the Sustainable Research and Education Project.

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

Our research addresses the Agricultural Production Systems Program Area (A5160) Priority, in that we will increase agricultural productivity and food security by generating data used to provide management advice that will allow farmers to achieve crop yields with reduced fertilizer input use while limiting nitrogen contamination of the nation's waters. Additionally, project results will aid in the development of socially sustainable agro-environmental policy.

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 have been disseminated to communities of interest using various communication platforms, including peer-reviewed publications, conferences, and symposium presentations, Extension publications and events, interviews, news and magazine articles, quarterly newsletters, a frequently updated website, field days, international and national meetings, public interviews via agricultural press, university events, and several agricultural and university workshops.

Publications:

1. Gardner, G., T. Mieno, and D.S. Bullock. “An Economic Evaluation of Site-specific Input Application Rx Maps: Evaluation Framework and Case Study.” Precision Agriculture (2021). https://doi.org/10.1007/s11119-021-09785-z.

2. Mandrini, Germán, David S. Bullock, and Nicolás F. Martín. “Modeling the Economic and Environmental Effects of Corn Nitrogen Management in Illinois.” Field Crops Research 261(2021). https://doi.org/10.1016/j.fcr.2020.108000.

3. Paccioretti, P., M. Córdoba, C. Bruno, F. Giannini Kurina, D.S. Bullock, and M. Balzarini. “Statistical Modeling for On-farm Experimentation with Precision Agricultural Technology.” In press, Agronomy Journal. July 2021.

4. Du, Q., T. Mieno, and D.S. Bullock. “Economically Optimal Nitrogen Side-dressing Based on Vegetation Indices from Satellite Images Through On-farm Experiments.” Submitted. Precision Agriculture, August 2021.

5. Li, X., T. Mieno, and D.S. Bullock. “The Economic Performances of Different Trial Designs in On-Farm Precision Experimentation: A Monte Carlo Evaluation.” Working paper, August 2021.

6. Li, N., D.S. Bullock, C. Butts-Wilmsmeyer, L. Gentry, G. Goodwin, J. Han, N. Kleczweski, N.F. Martín, P. Paulausky, P. Pistorius, N. Seither, N. Schroeder, and A.J. Margenot. “Distinct Soil Health Indicators Are Associated with On-farm Variation in Maize Yield and Tile Drain Nitrate Losses across Contrasting Nitrogen Applicaiton in Central Illinois.” Working paper, August 2021.

7. Kakimoto, S., T. Mieno, T.S. Tanaka, and D.S. Bullock. “Causal Forest Approach for Site-specific Input Management via On-farm Precision Experimentation.” In second round of reviews, Computers and Electronics in Agriculture. February 2022.

8. Li, N., D.S. Bullock, D.S., C. Butts-Wilmseyer, L. Gentry, G. Goodwin, J. Han, N. Kleczweski, N., N.F. Martin, P. Paulausky, P. Pistorius, N.J. Sieter, N.E. Schroeder, and A.J. Margenot. “Soil Health Spatiotemporal Variation and Relationships with Maize Yield and Tile Drainage Nitrate Loads in Central Illinois.” Submitted. Agriculture, Ecosystems and Environment. January 2022.

9. Mieno, T., X. Li, and D.S. Bullock. “Economic Evaluation of Geographically Weighted Regression Analysis for Site-specific Nitrogen Management.” Submitted. Field Crops Research. January 2022.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

This project has made significant progress in developing the Data Intensive Farm Management (DIFM) database and software, which involved work with Oracle to develop a database infrastructure for on-farm precision experimentation. Our ultimate objective is to increase agricultural productivity and improve food security by generating data used to provide management advice that will allow farmers to achieve crop yields with reduced fertilizer input use while limiting nitrogen contamination of the nation’s waters. Additionally, project results will aid in the development of socially sustainable agro-environmental policy.

Critical Issue

ENERGY EFFICIENCY AND RENEWABLE ENERGY APPLICATIONS IN ANIMAL FACILITIES

Project Director
Xinlei Wang
Organization
University of Illinois
Accession Number
1021116

ENERGY EFFICIENCY AND RENEWABLE ENERGY APPLICATIONS IN ANIMAL FACILITIES

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

The optimization design of a ground source heat pump (GSHP) system can be crucial in improving its performance and economic competitiveness. The effect of probabilistic uncertainties of design variables in a GSHP system was analyzed using a reliability-based design optimization (RBDO) method. This research will improve the design of a ground source heat pump (GSHP) system for different applications.

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.

An analytical borehole heat transfer model was selected as the frame of energy simulation in this research. With the goal of minimizing the cumulative costs over a twenty-year lifespan of the GSHP system, a non-linear optimization was carried out under three constraint factors imposed on the internal flow in ground heat exchanger: The inlet water temperature, water pressure losses and Reynolds number to ensure turbulent flow. Three design variables including depth of boreholes, ground pipe radius and mass flow rate, and two random variables at the installation site, including the groundwater velocity and ground thermal conductivity. Different uncertainty levels were assigned into the probability indexes of all five variables, which were studied under multiple reliability levels of all three constraints. The compromised increment of system cost to ensure the reliability was discussed, and the optimal combinations of design variables (borehole depth, pipe radius and mass flow rate) were also given under different designing scenarios. Results showed that uncertainties of variables can strongly affect the system reliability and total cost determination.

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

The findings and results from this project will be important for audiences (agricultural engineers and animal producers) to understand the complexity of the GSHP system and learn the important factors to consider for optimization of the system design, therefore to design and select the best practice to save energy and improve the sustainability of intensive livestock and poultry production.

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

The public will learn the potential benefits of GSHP in energy saving for different applications such as buildings and livestock facilities.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The optimization design of a ground source heat pump (GSHP) system can be crucial in improving its performance and economic competitiveness. The effect of probabilistic uncertainties of design variables in a GSHP system was analyzed using a reliability-based design optimization method. This research will improve the design of a ground source heat pump (GSHP) system for different applications. The results from this project will be important for audiences (agricultural engineers and animal producers) to understand the complexity of the GSHP system and learn the important factors to consider for optimization of the system design.

BIG DATA FOR ENERGY AND ENVIRONMENTAL ECONOMICS RESEARCH

Project Director

Peter Christensen

Organization

University of Illinois

Accession Number

1009833

EVIDENCE-BASED IMPROVEMENTS TO THE WEATHERIZATION ASSISTANCE PROGRAM

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

Residential energy efficiency is widely considered to be one of the most cost-effective strategies for reducing greenhouse gas emissions. As such, it has become central to climate policy around the world, with billions of dollars invested annually to unlock this potential. Independent of climate change policy, many energy efficiency programs focus on other benefits such as reduced energy costs for low-income households and reduced pressure on energy generation capacity. However, these programs will be less cost-effective than anticipated if realized savings from energy efficiency fall short of expectations. Recent analyses have found that ex ante projections overestimate energy savings in home retrofit programs, appliance rebate programs, and building codes, but very little is known about why projections are overestimating actual savings or what to do about it.

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 executed three large studies to help improve outcomes in energy efficiency programs and in the Weatherization Assistance Program (WAP) in particular. These studies were conducted in collaboration with the Illinois implementation of the program and have involved extensive engagement with more than thirty agencies that support the program. Study 1 made use of comprehensive data from the Illinois program to decompose and better understand the factors that contribute to a wedge between projected energy efficiency improvements and realized gains -- the study has been accepted for publication in a peer reviewed journal and has been presented at numerous academic conferences, as well as in meetings with the U.S. Department of Energy and collaborators in the Illinois WAP. We find that the majority of the shortfall in the program can be attributed to: (1) Bias in the model that the DOE uses to make funding decisions; and (2) Poor quality workmanship done by contractors in the program. Study 2 addresses problem #1 using cutting-edge machine learning techniques to improve on the DOE model. Study 3 addresses problem #2 using a two-year state-wide field experiment with contractors in the Illinois WAP, evaluating the impact of performance incentives on improvements in the quality of their work and resulting energy efficiency outcomes.

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

The research outlined above helped to identify the factors that drive underperformance in the nation's largest energy efficiency program and test the impacts of two potential solutions. Decision makers in Illinois and in federal programs are considering restructuring the program on the basis of this evidence.

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

Investments in residential energy efficiency are critical for reducing greenhouse gas emissions in the building sector. This research is making these investments more cost-effective for taxpayers in Illinois and across the nation. Recipients of weatherization services from the WAP are low-income households in Illinois and across the nation. This research increases the benefits that recipients receive in terms of reduced energy bills.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Our research has helped to identify the factors that drive underperformance in the nation's largest energy efficiency program and test the impacts of two potential solutions. Decision makers in Illinois and in federal programs are considering restructuring the program on the basis of this evidence.

THE USE OF BIOCHAR IN LIVESTOCK MORTALITY COMPOSTING

Project Director
Neslihan Akdeniz
Organization
University of Illinois
Accession Number
1014282

THE USE OF BIOCHAR IN LIVESTOCK MORTALITY COMPOSTING

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

This project addresses the effects of biochar use in animal mortality management. Biochar addition starting from 5% (w/w) increased the total net heat unit of composting bins by 19-34%, which would effectively eliminate AI H7N1. Wood-based biochar reduced the cumulative COD content of the leachate up to 87%. The co-composted biochar was used to grow lettuce in the lab without any adverse effects.

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 demonstrated that co-composting poultry mortalities with wood-based biochar at a minimum application rate of 5% (w/w) has some benefits. It helps to increase microbial activity and, therefore, compost temperature, which is critical when dealing with diseased mortalities. It helps to reduce the chemical oxygen content of leachate, and the end product can be spread to the field without having an adverse effect on crop growth or can be sold as a soil amendment to greenhouse owners.

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

The results of the project have been shared with Illinois livestock/poultry producers during Certified Livestock Manager Training workshops. We train about 1,000 livestock producers in three-year cycles on the environmental aspects of livestock production. The results of this study were incorporated into the best management practices presentation (both online and in-person training). Considering adopting new practices takes time, we will continue to disseminate the results of this study in our future workshops (we have ten to twelve workshops every year). The results were also shared with NCCC-09 multi-state collaborators.

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

This project specifically benefits livestock producers:

1. Reduce the risk of spreading animal diseases and contaminating groundwater sources.

2. Having a value-added product at the end, which can be sold as a soil amendment.

When we think about the project's broader impact, this project helps reduce the environmental impacts of livestock/poultry production.

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.

A Ph.D. student working on this project has successfully passed their final exam, and they will be graduating in Spring of 2022. Their dissertation will be available through the UI Library system.

Wang, Y. 2022. Advancing temperature development and sustainability of animal mortality composting systems using biochar amendment and utilizing the end-product to improve crop resilience. Ph.D. dissertation, University of Illinois at Urbana-Champaign.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

We have demonstrated that co-composting poultry mortalities with wood-based biochar helps to increase microbial activity and, therefore, compost temperature, which is critical when dealing with diseased mortalities. It helps to reduce the chemical oxygen content of leachate, and the end product can be spread to the field without having an adverse effect on crop growth or can be sold as a soil amendment to greenhouse owners. The results of the project have been shared with Illinois livestock and poultry producers during Certified Livestock Manager Training workshops. We train about 1,000 livestock producers in three-year cycles on the environmental aspects of livestock production.

Environment: Sustain natural resources in home and public spaces

Project Director
Elizabeth Welbes
Organization
University of Illinois
Accession Number
7001936

Gardening education series inspires action to improve home and community landscapes

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

Gardens and natural spaces have a wide range of documented health, cognition, and environmental benefits (Cameron et al, 2012). Gardens and other forms of urban vegetation contribute to environmental benefits, including biodiversity, wildlife habitat, pollinator support, storm water management, and reduced heat island effects. Urban trees, both street trees and those in private yards, provide benefits such as lower air pollution levels and improved temperature regulation, which increases comfort and safety and reduces energy use (McDonald et al, 2021).

In addition, gardens in the community improve the health of children and adults through improved social, mental, physical, and general wellbeing (Hardman et al, 2020). Gardening activities improve mental health through a range of mechanisms, including reduced stress and anxiety, reduced depression, improved cognition, improved sleep patterns, reduced cortisol levels, improved social networks, improved physical wellbeing, and reduced isolation. Recently, home gardens and community garden spaces have contributed to people's resilience and wellbeing during the pandemic. People turned to gardening for nature connection, individual stress release, outdoor physical activity and food provision (Egerer et al, 2022). Evidence showing the effectiveness of gardening during the pandemic is already emerging, with a recent review of several studies showing that nature exposure during the lockdown was associated with less stress, anxiety, depression, and fewer sleep disturbances (Labib et al, 2021).

Yet gardening decisions matter. Home gardening and landscape practices can have negative environmental impacts as well, such as increased greenhouse gas emissions associated with high fertilizer use (Howarth et al, 2002), water pollution resulting from fertilizer and pesticide runoff; and increased carbon emissions related to the use of peat (Margenot et al, 2018). Familiar management approaches are sometimes environmentally destructive. This underscores the importance of education and outreach to help gardeners understand and implement environmentally supportive gardening practices that work for them.

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.

University of Illinois Extension launched the **Four Seasons** gardening series in 2002 to share and leverage horticulture expertise throughout the state such as vegetable gardening, urban trees, flower gardening, native plants, pest control, pollinator support, house plants, and others. The Four Seasons Gardening webinar series is a coordinated team effort to make that expertise available as broadly as possible throughout the state regardless of locally available expertise and capacity. The Four Seasons team members were early leaders in providing online webinars viewed primarily at local Extension offices initially, now mostly viewed individually either live or on YouTube

Interest and need for gardening support in 2021 was high with 2,349 Four Seasons live webinar viewers across the 12 session webinar series, in addition to over 4,000 views on YouTube for the 2021 sessions. The two most popular sessions in 2021 for live viewers were *Adaptive Gardening* (324 participants) and *Therapeutic Value of Nature* (318 participants), while the most popular on YouTube to date are *Fruit Tree Pruning* (757 views through March 2022) and *Growing and Using Herbs* (523 views). Session-level participation across the series ranged from 83 to 324 per session. The Four Seasons gardening series reaches two main audiences: the gardening public and Extension volunteers (Master Gardeners and Master Naturalists). Through these two groups, the series contributes to ecosystem benefits of gardens and landscapes, healthy outdoor environments, and health and wellness benefits from gardening. Overall, 81% of webinar participants were Extension volunteers.

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

After each session, participants responded to an online program evaluation, generating 1,117 responses from viewers. Respondents were asked to rate their knowledge level before and after the session on specific areas covered in the session, using response options of “Very Low” (1); “Low” (2); “Moderate” (3); “High” (4); and “Very High” (5). In addition, respondents reported level of intent to implement recommended actions covered in the webinar series on a scale of “Very Low” (1); “Low” (2); “Moderate” (3); “High” (4); and “Very High” (5). To assess actual implementation of actions resulting from program participation, 123 webinar viewers completed a follow-up survey distributed at the end of the year. The following outcomes demonstrated the series effectiveness in achieving desired outcomes:

- **Knowledge increased**. Proficiency in the subject matter increased, as the share of participants reporting “high” or “very high” knowledge about the topics grew from 47% prior to the session to 93% after the session, overall. A statistically significant change in knowledge occurred for all topics. Overall, 79% of respondents improved knowledge in one or more topics.
    - The webinars with greatest share of participants reporting knowledge improvement included *Root Collar Disorders, Top 9 Vegetable Garden Insects, and What's that Bug? How to Identify Insects* with respectively 89%, 89%, and 88% of viewers reporting improved knowledge in one or more webinar topics.

- **Participants reported high intent to take action, using webinar information.** Overall, 84% of viewers indicated a “high” or “very high” intent to take one or more actions. Among Extension volunteers, 86% said they would apply information from the webinar series to their work as a volunteer, thereby influencing others through their enhanced competencies.

- **Knowledge and intent led to action.** Across the webinar series, 93% of respondents took one or more webinar-informed actions, with 3.8 actions reported per viewer on average. Both volunteers and general public program participants report actions taken following the webinar. Since planted environments confer numerous ecosystem benefits, including physical, emotional, and cognitive benefits, these actions contribute to healthier environments and communities through three targeted areas.
    - **Health/wellness benefits to individuals**. Five webinars targeted outcomes that promote the personal health and wellness benefits of gardening, including growing produce and herbs, therapeutic benefits, and benefits of youth engagement with gardening. With an average of 1.4 actions per session viewer for these topic areas, viewers who attended the sessions promoting personal health and wellness took an estimated 1,486 actions.

    - **Plant health and management**. Four webinars aimed to improve outdoor environments, including plant and tree health. Based on reported actions by follow-up respondents, viewers of these webinars took an estimated 964 actions contributing to healthy plants.

- **Sustainable landscapes and gardens.** Three webinars also aimed to strengthen sustainable landscape design and management, through control of insects and planting of green screens, fences, and borders. There were 563 estimated total actions by viewers contributing to sustainable landscapes and gardens.

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

While the long-term public ecosystem and wellness benefits of specific gardening actions are difficult to quantify, the Four Seasons Gardening series provides quantifiable public value by helping Master Gardeners fulfill their required annual 10 hours of continuing education that builds their knowledge and ability to serve their communities. In 2021, 2,717 Master Gardener volunteers contributed 166,123 hours, valued at $4,879,044, of work to support their communities. This impactful work supports healthy lifestyles, helps community members protect and appreciate their home and community landscape, addresses local food insecurity through support of food donation gardens, and provides hands-on opportunities for youth to explore plants and ecosystems.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The Four Seasons Gardening webinar series armed 2,349 viewers with information to guide gardening decisions and practices in 2021. In addition, more than 4,000 viewers experienced the recorded webinars on YouTube. As a result, participants reported increase in knowledge of webinar topics, high intent to take action based on webinar content and resources, and subsequently followed through on many intended actions. These actions supported health and wellness benefits to individuals and their families, plant health and management, and sustainable landscapes and gardens. While the long-term public ecosystem and wellness benefits are difficult to quantify, Master Gardener volunteers represent a significant portion of the webinar audience. By helping volunteers fulfill their 10 required hours of continuing education annually, Master Gardeners contribute to local food systems through supporting food donation gardens, engage youth with hands-on opportunities to explore plants and ecosystems, and educate residents about the health and wellness benefits of gardening.

Illinois Extension's Master Gardener core training gets a big, green thumbs up!

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

Volunteers are the lifeblood of University of Illinois Extension. Through the Master Gardener program, University of Illinois Extension partners with committed citizens to enrich their community environments through continuing education transformed into community service. Master Gardeners represent a special and unique audience with learning goals for themselves and goals to make a difference in the world around them. There is growing evidence that time spent around plants and in green spaces has many benefits including improved health, better interpersonal relationships, and a higher quality of life. Sustainable home landscapes also increase property values and build stronger ecosystems for plants and wildlife. The **Master Gardener Program** builds the capacity of adult volunteers so they are better equipped to enhance their communities through gardening outreach activities, thereby amplifying the impact of Illinois Extension.

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 order to develop competence to serve in their mission critical role, volunteers need access to high quality training provided by University of Illinois Extension. Master Gardeners initially develop the competencies they need through an intensive, ten-session core training curriculum. The core training covers topics including plant health and management, protecting natural resources in gardens and landscapes, sustainable garden practices, issues associated with invasive plants, benefits of native plants, pollinator and beneficial insect practices, and growing fruits and vegetables. They continue to build relevant knowledge as long as they are volunteers through continuing education provided by Illinois Extension educators and specialists as well as by outside experts.

In 2018, Extension launched an online option for the core training to expand access for those who prefer a self-directed, on-demand training modality due to learning preferences and need for schedule flexibility. While this was initially an alternative to in-person training, pandemic gathering restrictions prohibited delivery of the traditional in-person format, elevating the importance and value of the online course to support the training needs of new volunteers. A hybrid training option was also offered to blend live online sessions and independent study with local small group discussion for those who preferred an interactive, interpersonal learning environment. The in-person training option resumed in some locations in fall of 2021.

In 2021, 380 people participated in the approximately 60 hours of required training throughout Illinois, including 239 in the self-paced online Master Gardener training course. Participants gave the training a big thumbs up, with 97% feeling satisfied with the course. One satisfied participant commented, "*I'm so excited to put what I've learned into practice via volunteering. I'm sad we couldn't do the training in person but I have to say that having been able to do it online and on my schedule really helped me manage my time better. Thank you for this opportunity. I'm excited to see how I can better serve my community.*"

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

Based on results from a post-program survey completed by 358 respondents in 2021, the Master Gardener core training increases participants' knowledge and abilities essential to their role as both home gardeners and volunteers. In fact, participant knowledge increased in all core thematic topics. The share with "high" or "very high" knowledge increased from an average of 13% prior to the program to 80% after the program across the seven main topic areas covered in the core training. Participants reported the greatest knowledge improvement in the area of *plant health and management*, a topic that is foundational to their role as volunteers. Mastery of *knowledge of garden practices to encourage and preserve pollinators and beneficial insects* was evidenced by 88% of participants rating their knowledge as "high" or "very high" after the program compared with only 18% rating their knowledge at that level prior to the program. More than 80% of participants rated their knowledge of *how to protect natural resources, such as soil and water, in gardens and landscapes* and *sustainable landscape practices* as "high" or "very high" based on what they learned in the core training.

The core training also improved participants' abilities to *share information with others about proper garden and landscape maintenance* and to *identify and use accurate, research-based sources for garden and landscape information* with 72% and 79% of participants, respectively, rating their ability to take these actions as "high" or "very high" as result of the core training. Only 8-11% rated their ability to take these actions as "high" or "very high" prior to the program. Most trainees start to put their knowledge to work immediately. By the training's end, 87% report having used information to affect planning or decision-making around gardening or landscapes, and 81% had already used the information to inform action taken at their home or some other location.

Participants have a range of goals in participating in the program, with most participants interested in increasing knowledge of gardening in general (99%), for use at their homes (97%) and to prepare for Master Gardener volunteer service (86%). Nearly all (92%) of respondents said that their goals were "mostly" or "fully" met.

Evaluation results suggest that the core training, delivered across multiple modalities, not only met programmatic goals for preparing volunteers to be better equipped to share gardening information with others in their communities, but also met participants' goals. In a recent survey of all current Master Gardener volunteers, almost all say they agree or strongly agree that their work is valuable (98%) and that it makes a difference in their community (97%).This alignment of outcomes provides evidence that the core training has mutually beneficial value; an important factor in continually expanding the cadre of Master Gardener volunteers.

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

In 2021, 2,717 Master Gardener volunteers contributed 166,123 hours, valued at $4,879,044 of work to support their communities. The 278 gardens they supported in communities throughout the state, provided education; food donation; youth engagement; training/life skills; demonstration; therapeutic uses, and environmental benefits such as pollinator support or native species. From these gardens, food pantries and similar community resources received over 161,000 pounds of produce. Master Gardeners also donated an additional 6,714 pounds of produce from home gardens, amounting to a value of $241,808 of produce available for distribution to those in need.

In addition to their community stewardship contributions to the public, Master Gardeners also play a critical role in providing education and outreach in their communities through educational programs and through answer desks, tables, and help hotlines that provide gardeners with information services targeted to their needs. In 2020 and 2021, Master Gardeners responded to over 135,000 gardening inquiries from the public. Feedback received through a pilot evaluation conducted in five help desk locations showed that 93% of those served considered the information they received "somewhat" or "very helpful." The value and impact of these services is illustrated by comments such as "*This info confirms and supports what I had been doing and gave me new info on how to deal with a nasty invasive*" and "*I feel confident that next year I will be better prepared to care for my trees.*" One comment expressed repeated value, saying, "*I always get a good answer for my problem and it comes very quickly. Don't know how I'd do without you.*"

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Program evaluation findings from 2021 indicate that Extension's Master Garden core training met both participant and programmatic goals. The 60-hour core training program was provided to 380 participants, with 239 of these participants electing to use the self-paced, online training. Nearly all (97%) were satisfied with the course and 92% said their goals were met. Participant knowledge increased in all core training thematic areas and more than 70% of learners reported a high ability to share information with others about proper garden and landscape management to identify and to use accurate, research-based sources for garden and landscape information after completing the program. The core training enables Master Gardeners to support their communities. In 2021, 2,717 Master Gardener volunteers contributed more than 161,000 hours, valued at more than $4.8M of work to enhance their communities and the lives of community residents.

Type	Projects / Programs
Projects / Programs without a Critical Issue	0

Not Provided