

Ohio (Ohio State University) Annual Report - FY2021

Report Status: Approved as of 07/08/2022

Contributing Organizations

Ohio State University

Executive Summary

Overview

The College of Food, Agricultural, and Environmental Sciences (CFAES) is known as the “cornerstone college” of The Ohio State University and encompasses three mission areas – teaching, research, and Extension. Though our efforts are divided across three campuses (Wooster, Columbus, and Statewide) we are connected by our mission: We sustain life.

To ensure student success, focus CFAES scholarship and discovery, engage stakeholders and partners, and enhance efficiencies and resources in the college, CFAES actions are guided by our four Grand Challenges:

- Sustainability – a simultaneous focus on viable agricultural production, food security and safety, and environmental and ecosystem sustainability.
- One Health – the intersection or interaction of human, animal, plant, and environmental health.
- Rural-Urban Interface – exploration of the tensions and opportunities created in the communities, industries, policies, economies, and communications between rural and urban residents.
- Leadership – preparation of the next generation of scientists and leaders.

CFAES recently updated our strategic plan to improve and transform how we meet our mission and Grand Challenges and ensure that we make the greatest impact. The CFAES Values and Goals below guide our work and actions at all levels.

Goal 1: Student/Learner First Philosophy

CFAES teaching reaches across the lifespan

- 60,000+ youth served through 4-H programs
- 2,800 undergrad and 500 graduate students pursuing degrees
- 2 million plus lifelong learners in extension programs

In-person teaching and learning was prioritized in our research labs, on campus, and through Extension programming. Ohio State University Extension (OSU Extension) continued to offer certification programs so people did not lose their license to practice. Our hands-on learning allows us to prepare the next generation of scientists and leaders as well as creating opportunities for lifelong learners.

CFAES was also actively involved in workforce development of students through the Ohio 4-H Pathways career and college readiness program and the mikeroweWORKS Work Ethic Certification at Ohio State ATI (Agricultural and Technical Institute), the associate-degree-granting unit of CFAES.

Goal 2: Innovative Scholarship to Sustain Life

CFAES is a research powerhouse. During FY21, CFAES researchers had 344 grants awarded totaling \$50 million as well as 25 new innovators, 18 patent filings, 7 active startups and 38 invention disclosures. In the last 18 months, more than \$2.5 million dollars have been raised that benefits Extension programming.

COVID-19 remains a critical research topic for CFAES. Dr. Lyda Garcia and Dr. Joy Rumble worked with meat packing plants nationwide to increase workers' use of face masks to slow the spread of COVID-19. The pandemic has also affected meat supply chains and highlighted the need for more meat processors. In response, Garcia and a team from CFAES created a free [online toolkit](#) for people considering

starting up a meat processing facility. Scientists in the [Center for Food Animal Health](#) are working to develop a nanoparticle COVID-19 vaccine and, along with Ohio State veterinary colleagues, identified the transmission of SARS-CoV-2 to the wild deer population in Ohio. OSU Extension has also played a role in response to the pandemic through its partnership with the CDC to address vaccine hesitancy.

A high priority issue in our Plan of Work was prescription drug abuse and opioid addiction. The opioid crisis is a mental health crisis that has worsened during the pandemic. COVID-19 is taking a heavy toll on farmers' mental health. In response to this crisis, OSU Extension has partnered with the Ohio Department of Agriculture (ODA) on a grant entitled "Bridging the Gap for Agricultural and Rural Mental Health Training in Ohio" awarded by NIFA. This grant is providing education and outreach of mental health programming to the agricultural community and certified OSU Extension educators as trainers in Mental Health First Aid.

A second high priority for research and Extension is water quality in Ohio. A key initiative is to maintain water quality in Lake Erie while maintaining viable agricultural productivity. OSU Extension water quality associates, funded with support from the Natural Resources Conservation Service and Cargill, have visited 300 Ohio farms. The water quality associates have conducted 26 on-farm applied research trials and partnered with faculty on regional soil health and water quality projects. The projects' outcomes were shared with producers and summary reports were included in the college's eFields report. CFAES researchers working on water quality are studying how best management practices (BMP) such as fertilizer placement, reduced application rates, and cover crops can improve water quality through nutrient reduction.

Goal 3: Capacity Building of Our People and Our Communities.

People are our greatest asset and CFAES strives to build on the success of our people. Changing workforce dynamics, COVID-19 pressures, market competition, economic drivers, an increasing desire for a more balanced approach to how life and work interface, and a need for diversifying our talent are all factors that we must continue to address.

- CFAES has hired 18 new research and Extension faculty during FY21 and is currently interviewing to fill 25 new research and Extension positions, pointing toward a bright future for research projects and Extension programs in the coming years.
- CFAES continues to support flexible work arrangements to achieve a reliable and productive work environment and work/life balance.

CFAES is committed to communities across Ohio.

- OSU Extension educators assisted Noble County in obtaining a grant from the Appalachian Regional Commission to determine the next steps needed for broadband expansion.
- OSU Extension partnered with Ohio Treasurer Robert Sprague in an expansion of the Real Money. Real World. financial literacy program.
- Funding from Nationwide has been applied to non-credit course work and certificate initiatives including the Certified Crop Adviser Exam Study Course, the Ohio Township Advanced Leadership Academy course and a new 20 Questions in Plant Diagnostics Workshop course.
- The Ohio Integrated Pest Management Program was able to conduct pest management related workshops, field days, and webinars for our diversified stakeholder audience with funding from the USDA NIFA Extension Implementation Program.

Goal 4: Partner of Choice

CFAES wants to engage our entire community, internal and external stakeholders.

- The 59th Annual Ohio State University's Farm Science Review returned to an in-person format in September of 2021. More than 70,000 people attended to view educational events, field demonstrations, "ask the expert" talks, and interact with 600 exhibitors.
- In a partnership with Nationwide, the [Knowledge Exchange](#) team collaborated with our college's researchers and Extension educators to develop a suite of communications products and data tools. This resource is designed to connect Ohioans to data and research on key topic areas in a way that is easy to access and understand.
- CFAES is also partnering with: NBC4, Apple, the Center of Science and Industry (COSI), and the Ohio Fair Managers Association.

Goal 5: Resource Stewardship in a One-College Model

CFAES continues to transform and improve our physical environment across our three campuses.

- The new science building on the CFAES Wooster campus was completed and opened in January 2021. In addition to providing modern research space for the entomology department and classrooms and labs for ATI students, this building also serves as a social gathering place for students and researchers alike.
- Significant progress has been made on the Controlled Environment Agriculture Research Complex, an interdisciplinary research space at Waterman Farm on the Columbus Campus.
- Fundraising is also underway for our Multispecies Animal Learning Center, which will also be located on Waterman Farm on the Columbus Campus.

The work we have been doing has allowed us to take advantage of opportunities to propel the college forward in fulfillment of our mission: We sustain life.

Critical Issue: Animal Systems

This is a Central State Critical Issue

Critical Issue: CSU - Building new farmers, supporting limited-resource and urban farms

This is a Central State Critical Issue

Critical Issue: Advanced Technologies and Commercialization Systems.

This is a Central State Critical Issue

Critical Issue: CSU - Engaging Communities and Transforming Lives

This is a Central State Critical Issue

Critical Issue: CSU - Food Nutrition and Health Systems

This is a Central State Critical Issue

Critical Issue: CSU - Preparing our youth for the future

This is a Central State Critical Issue

Critical Issue: CSU - Promoting food nutrition and health for socially-disadvantaged communities

This is a Central State Critical Issue

Critical Issue: CSU - Natural Resources and Environmental Systems

This is a Central State Critical Issue

Critical Issue: CSU - Supporting small and medium-sized farms

This is a Central State Critical Issue

Critical Issue: CSU - Plant Systems

This is a Central State Critical Issue

Critical Issue: OSU - Economic Vitality

Nationally and within Ohio, more and more people are leaving the cities and suburbs to move to rural areas. These migration and moving patterns are causing a widening gap between the rich and the poor, poverty clusters and quality of life and environmental issues. More than 1 million Ohioans do not have access to high-speed internet, mainly in rural areas. The most recent analysis from the [C. William Swank Program in Rural-Urban Policy](#) determined that there are between 92,000 – 170,000 Ohioans addicted to drugs, costing the state \$6.6 – \$8.8 billion. Employment in the Appalachian coal industry has declined 97% during the last century, leaving coal workers and a number of Ohio counties suffering economically. Deglobalization and increasing isolationism are increasing the need to study how policy change impacts regional economies and resource systems. To address these challenges, our experts are studying issues at the rural-urban interface including opioid abuse, changes to industry and the workforce, lack of broadband internet access, and environmental issues. It is crucial we study and address these issues to ensure a sustainable Ohio economy and environment as the Ohio population becomes more rural.

EXTENSION

Extension provides support for community and economic development in counties across the state. Along with numerous leadership development seminars and certificate programs, our Community Development work in leadership has expanded. We now work directly with business and nonprofit leaders, local government directors, and other administrators to equip them with process skills, which builds

their capacity for impact. Programs include team alignment, organizational culture, DEI, strategic thinking, coaching, mentoring, decision-making, and other critical leadership theories for improved practice. Once equipped, these leaders can better reach, teach, and assist an exponential number of employees, clients, faculty, and staff.

In Noble County, OSU Extension provided guidance and grant writing assistance, which resulted in a \$50,000 grant from The Appalachian Regional Commission with \$21,500 in matching funds from OSU Extension for a Broadband Technical Assistance Project. Broadband access is a critical community infrastructure and the COVID-19 pandemic and subsequent need for telehealth and telework options underscores this need further. Noble county is the “least connected” county in Appalachian Ohio and this project will assist community leaders in determining the next step in broadband expansion.

RESEARCH

Dr. Mike Betz, a member of the [Institute for Population Research](#), and collaborators are working to determine the economic and demographic impacts of shale oil and gas drilling as well as how economic and contextual factors in rural areas impact drug overdose deaths. Oil and gas drilling activity tended to attract migrants with lower education levels while causing residents with higher education to leave the community more often. Oil and gas drilling activity also appeared to play a role in overdose death rates, with higher rates occurring where there was more activity.

Dr. Lauren Jones is working to help researchers and policy makers measure the true value of the Earned Income Tax Credit (EITC). The EITC is the largest anti-poverty program in the United States and has been shown to have short term health benefits in young mothers. Dr. Jones hypothesized that there may also be long-term health effects since the increase in income can lead to increased funds for healthy food, health care and lower stress levels. She and her team were able to study survey answers by a cohort of women born between 1957 and 1964 to determine their health outcomes at age 50. They found that a more generous EITC during one’s life is related to improved physical health at age 50, with reduced incidence of physical health issues and reduced diagnoses of cancer and lung issues. Reducing the onset of disease until later in life will reduce healthcare costs for the economy at large since healthcare among Americans over age 65 is publicly funded.

Dr. Brent Sohngen leads Ohio State's [Environmental Policy Initiative](#), which stimulates and focuses systematic collaboration in environmental policy nationally and internationally. His research focuses on the economics of land use change, the design of incentive mechanisms for water and carbon trading, carbon sequestration, and valuation of environmental resources. Sohngen has been helping to educate farmers and landowners about the value of their carbon resources. Carbon markets have emerged in recent years as large international companies have vowed to offset the carbon dioxide they put out in emissions from producing and transporting products. That can be done by paying farmers and foresters to take measures that store more carbon in plants and soil through activities such as starting no-till farming, planting cover crops or trees and more intensively managing existing forests. “I think it’s something that’s emerging,” Sohngen said of carbon markets. “Within a decade, I wouldn’t be surprised to see 20% to 40% of Ohio farmers involved in a contract.”

Dr. Drew Hanks has focused on research related to federal nutrition assistance policies (Accession number 1021854). He examined data from food pantries and the utilization of WIC in Ohio. By studying food pantry data from January 2019 until October of 2022, Hanks noted that food pantry visits increased during the first months of the COVID-19 pandemic. He was also able to show how participation in WIC reduces nutrition risk for children in the program. Both findings demonstrate the importance of food banks, especially during crises.

Critical Issue: OSU - Environmental Quality and Sustainability

Ohio State environmental experts educate Ohioans about their individual impact in a global community, while teaching them to be good stewards of the planet.

EXTENSION

Ohio has 125,000 lakes, reservoirs, and ponds as well as 60,000 miles of rivers and streams. Water quality issues such as harmful algal blooms in Lake Erie caused by phosphorous run off are a serious concern for the state. OSU Extension has trained farmers about water pollution and the connections between production practices and environmental stewardship. Through Cargill’s and the Natural Resources Conservation Services support, water quality associates with OSU Extension have made more than 500 contacts with farmers and 300 on-farm site visits. Part of the team’s work involves running field trials to determine the effects of applying varied rates of phosphorus, nitrogen, and potassium fertilizers to cropland. Extensive soil testing has been done on fields to see how planting cover crops and minimally tilling the land affects soil health. New water quality monitoring stations have been set up to show trends in nutrient runoff rates.

Pesticide application businesses, public agencies, and farms need to manage pests safely and effectively. Employers need employees who are licensed, trained in best management practices, and current with state and federal regulations. The commercial and private pesticide applicators require continuing education to maintain their license and livelihoods. OSU Extension has been designated by the Ohio Department of Agriculture as the agency to deliver programming for pesticide education. Nearly 8,000 commercial and private applicators participated in re-certification courses. One of the primary goals of our pesticide education program is to improve the water quality in Ohio by training pesticide applicators in best management practices.

RESEARCH

Losses in biological, chemical, and physical water quality threaten the environment, as well as human health and well-being. For example, the frequency and severity of harmful algal blooms in both Lake Erie and the Ohio River have resulted in losses of water supply. Dr. Robyn Wilson and collaborators in the School of the Environment and Natural Resources used surveys and instrumented fields to understand farmer conservation decisions and their impact on water quality. For example, they were able to develop statistical models of how farmers allocate and manage their land use in response to economic signals and weather patterns. They also explored the drivers and constraints of farmers' adoption of conservation practices. Finally, they worked on production of a documentary “[...And Water For All](#)” about water affordability in Ohio.

Dr. Sami Khanal (accession number 1019638) is to understand the influence of nitrogen management practices on corn yield and develop methods to increase yield while preserving natural ecosystems and minimize environmental impacts. She collaborated with OSU Extension water quality associates to collect soil and biomass samples from farmers' fields that were planted in cereal rye. These were then analyzed for physiochemical properties and ammonium and nitrate concentration. They used remote sensing (e.g., sensors on drones) in parallel to assess the efficacy of this method in monitoring cover crop biomass and biomass nutrients and develop models to retrospectively monitor cover crop performance at field and landscape scales.

Dr. Jay Martin, a faculty co-lead for Healthy Land and Water Systems in the [Sustainability Institute at Ohio State](#), is Project Director on a pilot watershed project in northwestern Ohio designed to demonstrate that agricultural conservation practices—if used on 70% of the farmland in a watershed and evaluated on a watershed scale—can help meet Lake Erie's water quality goals. The goals focus on reducing nutrient runoff from agricultural fields in the lake's watershed, especially phosphorus runoff, to reduce phosphorus levels entering the lake by 40%, resulting in reduced harmful algal blooms.

Dr. Lingying Zhao and her group, who are working to develop sustainable animal production systems. The animal production industry significantly contributes to the US economy, however air pollutant emissions from the industry can cause significant environmental concerns. Ammonia emission from animal production accounts for 80% of human-caused ammonia release. The development of sustainable animal production systems is needed to reduce these emissions. Dr. Zhao is developing model tools to estimate air pollutant generation, distribution, and dispersion of NH₃ emission from poultry layer facilities in Ohio. These tools can enable fair assessment and effective control of NH₃ emissions. She also has been conducting field performance tests of electrostatic precipitators and spray scrubbers for dust control and pathogen deactivation at layer houses, which will help mitigate particulate matter emissions from these facilities.

Dr. Yael Vodovotz, a member of the [Center for Advanced Processing and Packaging Studies](#), is researching sustainable bioplastics for food packaging. Concerns about environmental pollution have stimulated her research in biobased biodegradable plastic materials. One promising bioplastic is poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), but its use is limited by brittleness and poor processability. To overcome these challenges, Dr. Vodovotz and Dr. Katrina Cornish have developed a technology which significantly improves PHBV toughness and processability through reactive extrusion with natural rubber (NR) and a novel bio-based plasticizer from food waste. The novel rubbery bioplastic has shown promise for freezer-to-microwave food packaging.

Dr. Ajay Shah and his team are studying the sustainable production of lactic acid and renewable fuels. Lactic acid has a number of applications in foods, textiles, and pharmaceuticals and is often produced by chemical synthesis from petroleum products. Shah's group studied bio-based lactic acid production and found the global warming potential (GWP) to be 63-88% lower than petroleum-based production at approximately the same cost. This group also analyzed the costs and GWP of renewable jet fuel production from pennycress, AKA “Stinkweed,” a common farm weed. They estimated the environmental impacts of growing pennycress, transporting it to a biorefinery, and converting it to a usable jet fuel. According to Shah, renewable jet fuels are not yet financially competitive with fossil fuel-based fuels. But calculating the environmental impacts of alternative bio-based fuels should help both farmers and policymakers as they try to limit carbon dioxide in the Earth's atmosphere and, hopefully, to slow or stop climate change.

Critical Issue: OSU - Food Security and Production

A sustainable food system not only benefits producers and protects consumers, but also ensures a safe food supply while feeding a growing population. Unfortunately, food security remains a pressing issue in Ohio. According to Feeding America, 1.5 million people in Ohio are facing hunger, a number that includes approximately 450,000 children. While many Ohioans don't know where their next meal is coming from, food waste is also a problem. Food waste and unsustainable practices throughout the food chain contribute to natural resource waste, climate change, food insecurity, and financial loss. CFAES researchers have created a number of partnerships on the local and national levels to analyze consumer behavior, consumer perceptions, and local food value chains to find ways to make our food system more sustainable, resilient, and efficient.

EXTENSION

OSU Extension is partnering with the Office of Student Life to build awareness about the majors within our college but particularly, the work of Extension and recruitment for future Extension professionals. Recent collaborations with the Office of Student Life included a service project to celebrate Urban October, where 500 volunteers packed 188,000 shelf-stable meals and OSU Extension and hundreds of local organizations distributed those meals at five locations in the Mahoning Valley area to food insecure individuals.

When food insecurity issues were worsened by the pandemic, Master Gardener Volunteers from across Ohio stepped up and grew and donated more than 85,000 pounds of fresh produce to food pantries across the state. The pandemic also increased people's interest in growing their own food. Extension educator Tim McDermott, who writes a blog called *Growing Franklin County*, produced a virtual class on how Ohioans can grow their own vegetables all twelve months of the year.

OSU Extension, in partnership with faculty in the Department of Food, Agricultural, and Biological Engineering and Ohio State's College of Engineering, conducts research and educates producers about best practices that increase yield and profitability. The eFields program, which has expanded to 249 research sites in 45 counties, is dedicated to advancing production agriculture through the use of field-scale research. The [2021 eFields Report](#) is a culmination of the research conducted during the past year on partner farms throughout Ohio. With our new [interactive eFields map](#), stakeholders can easily find relevant reports in the eFields research from the past five years.

RESEARCH

Dr. Brian Roe and collaborators analyze consumer behavior, consumer perceptions, and local food value chains to find ways to make our food system more sustainable, resilient, and efficient. Food waste is a huge problem – more than 40% of food that is produced is never eaten, which contributes to lost resources, pollution, economic costs, and decreased food security. The Ohio State researchers partnered with the Solid Waste Authority of Central Ohio (SWACO) and the City of Upper Arlington using U.S. EPA funding to assess the effectiveness of an educational "Save More Than Food" campaign. Analysis of the campaign showed it was responsible for a net food waste reduction of 60% in the city of Upper Arlington when compared to food waste on the national level.

The goal of Dr. David Barker's research (accession number 1011108) is to produce healthy, economically profitable, environmentally safe and socially responsible livestock forage. His research includes evaluation of different species and varieties of forage, developing growth models for Ohio grasslands, characterizing the nutritive value and herbage accumulation of alfalfa either alone or in an alfalfa-grass mixture as well as field trials of potato leafhopper resistant varieties. Dr. Barker also assisted growers in dealing with a rare fall armyworm infestation that occurred in Ohio in the fall of 2021.

Dr. Luis Rodriguez-Saona, a member of the [Food Innovation Center](#), uses spectrophotometric technique to analyze food quality and safety. Aflatoxins are highly toxic, carcinogenic toxins produced by certain fungi and found on agricultural crops including peanuts. Analytical methods to detect these toxins have traditionally been laborious and time intensive. Rodriguez-Saona's lab is pioneering a technique using infrared spectrophotometers to detect aflatoxin contamination on the surface of peanuts. This method could be used in the field and offer a time-sensitive approach to detection of these compounds.

Dr. Andrea Gschwend, who is working to identify genetic variation that provides grapevines with heightened resilience to stress. Grapes are the highest valued fruit crop in the United States and the wine grape industry has a billion-dollar impact in Ohio's economy. With increasing erratic weather events, we need cultivated grapevine varieties that are resilient to diverse environmental stress and local pathogen pressures to increase vineyard productivity. The Gschwend lab used a comparative approach to make significant strides in identifying the genes that underlie important adaptive traits such as cold tolerance, fungal resistance, and response to insect herbivory in wild grapevines that make them resilient to many environmental stresses. These genes can be used as targets for molecular breeding or genetic engineering to incorporate them into grapevine cultivars, making the cultivated grapevines more resilient to a broader range of

environmental stress, increasing yield without losing important fruit quality traits. These new varieties will have broader growing regions, contributing to the economic impacts of the grape industry in these impacted states, and will require less input of pesticides and fungicides, making these new varieties more cost effective and environmentally sustainable.

Dr. Lisa Bielke's research focuses on poultry enteric health with emphasis on non-antibiotic strategies to prevent and treat disease. The chicken gastrointestinal tract (GIT) is quickly colonized after hatch and these pioneer colonizing bacteria are known to affect chick quality and immune function. Dr. Bielke and her group are manipulating GIT microflora through in ova injection with specific bacterial strains and measuring the influence these bacteria have on innate immune responses and inflammation. Her group has also made significant progress on assays to determine gut health and the effect primary colonizing bacteria have on immune function. For example, they found that primary colonization with Enterobacteriaceae may induce a state of tolerance, which can allow opportunistic and food safety pathogens to persist. The results of this research may lead to improved gut health and improved sustainability of animal agriculture through reduced disease.

Critical Issue: OSU - Health and Wellness

Our critical issue of Health and Wellness is an important part of our mission to sustain life. Nearly one third of adults and about 20% of children in Ohio are obese, which can lead to or exacerbate a number of health conditions. According to the Ohio Department of Health, Ohioans have a higher-than-average rate of chronic diseases such heart disease, cancer, COPD, diabetes, and kidney disease when compared to the United States as a whole. We believe that Ohioans should have a positive state of mental and physical health, which includes the prevention of disease, by creating and supporting healthy environments in homes, schools, workplaces, and communities.

According to the 2021 State of Obesity Report, "The COVID-19 pandemic added new obstacles and exacerbated existing barriers to healthy eating and physical activity in 2020 and 2021, and deepened longstanding racial and economic inequities in the United States. Emerging data suggests eating habits shifted, physical activity declined, stress and anxiety increased, food insecurity worsened, and many Americans gained weight throughout the pandemic, a sharp reminder of the effects that underlying social, economic, and environmental conditions have on the health and well-being of Americans. Many of direct and indirect effects of the pandemic fell disproportionately on certain populations, including low-income communities and communities of color."

EXTENSION

OSU Extension is working to improve health and wellness with their community nutrition programs, SNAP-Ed and EFNEP. Funding for the SNAP-Ed program is consistently one of the largest awards at the university and reaches tens of thousands of participants (children and adults) in every county across the state. OSU Extension SNAP-Ed program assistants teach classes on nutrition, physical activity, food safety, and purchasing food on a budget.

Mental health is an important issue for Ohioans as a whole and especially for farmers. As stated by CFAES Dean, Dr. Cathann A. Kress, "Our farmers and producers are facing incredible stressors. Many farmers are faced with unpredictable issues and concerns daily involving personal health and injuries, equipment and parts, animal health, weather, and crops. COVID-19 came at an already challenging time for farmers, adding uncertainties and complexities with supply chain and additional stressors with health and family concerns. Many mental health professionals are not trained, nor do they have direct experience working with the agricultural sector and their unique challenges."

OSU Extension has partnered with the Ohio Department of Agriculture to meet this need. Our Farm and Ranch Stress Certification courses are targeted at mental health care professionals seeking to better understand the stressors of farm and ranch life. The lack of knowledge surrounding the agricultural industry is an identified barrier to mental health care for farmers and ranchers.

OSU Extension also provides training for Extension professionals to become Certified Adult Mental Health First Aid Instructors and offers trainings in Mental Health First Aid for employees at Ohio State and members of the ag community to learn about the warning signs and symptoms of mental health issues. We also are helping to raise mental health awareness and advocacy on a national scale and have distributed nearly 25,000 copies of the 4-H project book *Your Thoughts Matter: Navigating Mental Health*, since its introduction in 2017. That includes 20,500 sold nationally and authors Jami Dellifield and Amanda Raines have contributed to other National 4-H mental health curricula as well.

RESEARCH

Dr. Ingrid Adams has been studying the effect of stress management, healthy eating and physical activity on African Americans living with hypertension and mild cognitive impairment. African Americans are at higher risk of developing Alzheimer's disease, which may be attributed to uncontrolled hypertension. Adams and collaborators piloted a randomized-controlled trial, *Mindfulness in Motion (MIM)* and

the Dietary Approaches to Stop Hypertension (DASH). Interventions included sampling healthy new foods, homework assignments to practice the DASH diet and information about serving sizes and food groups. The results of the MIM DASH pilot indicated that the intervention was feasible and sets the stage for a future larger trial to establish the efficacy of the MIM DASH approach.

Dr. Sheila Jacobi research in swine nutrition (accession number 1011106) can also have positive impacts on human nutrition. In her project, she looked at feed and management alternatives to in-feed antibiotics and their effect on animal wellbeing. Specifically, she focused on the effects of probiotics and lipids on piglet gut health. These piglet models can be used to improve infant nutrition such as in the development of new baby formulas.

Flavor quality is an important attribute in food selection. Dr. Devin Peterson is studying the flavor properties of food with a focus on healthier food choices (accession number 1012391). For example, Americans often fail to consume the amount of whole grain foods that they should. Dr. Peterson's group identified several compounds that contribute to the dislike of whole wheat bread. These findings provide a basis to develop a better tasting whole wheat bread, which can increase consumption and promote health impacts.

Critical Issue: OSU - Thriving Across the Lifespan

EXTENSION

OSU Extension has always worked collaboratively within communities to identify what our unique contribution will be in providing solutions and ensuring that we are not duplicating efforts already in place. We have developed partnerships based on these unique set of circumstances locally. These partners engage with us to build coalitions, fund programs and people, and create strategies for building pathways for Ohioans to thrive.

OSU Extension and 4-H professionals partnered with Ohio Treasurer Robert Sprague to advance and expand the use of the college's *Real Money. Real World.* financial literacy program statewide. This program was developed by OSU Extension, designed for youth ages 12-18, and includes an interactive spending simulation that provides participants the opportunity to make lifestyle and budget choices similar to those they will make as adults. The program is designed to increase financial awareness using real-life scenarios such as what it costs to maintain a household, what it costs to care for a child, and the level of education required for the job they desire.

As part of its Community Education Initiative, Apple provided the Ohio 4-H Youth Development Program with devices, programmable robots, and professional learning and support. Apple's gift of \$1.2 million in devices and technology to OSU Extension has given our current 4-H professionals access to technology needed to reach 6,274 4-H youth in 44 counties in 2021.

Successful Co-Parenting (SCP) is an educational program for parents of minor children who are in the process of separating or divorcing. Many counties offer this class in partnership with the county family court. Divorce affects approximately 28,000 children under the age of 18 in Ohio each year. The SCP class is designed to equip parents with knowledge, skills, tools, awareness, and strategies to help their children adjust to their parents' divorce now and in the future.

RESEARCH

Dr. Mary Rodriguez studies food security and community resilience in re-settled refugee populations (Accession number 1012048). Dr. Rodriguez specializes in community leadership and engages with community members to create a resiliency framework with the intention of reducing household and community food insecurity. COVID-19 posed great difficulties in getting to work for members of these communities. Dr. Rodriguez and collaborators were able to develop a needs assessment questionnaire to address the needs of a primarily New American community in Columbus, OH. They were also able to create and support a local organization to learn more about the effects of COVID-19 on the community. Future work will include exploring how households have adapted to changes brought on by the COVID-19 pandemic.

Merit and Scientific Peer Review Processes

Updates

None

Stakeholder Input

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

None

Methods to identify individuals and groups and brief explanation

None

Methods for collecting stakeholder input and brief explanation

None

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

We collected and analyzed primary and secondary data and held various listening sessions with our employees, stakeholders, state level Extension advisory councils as well as monthly meetings between Dean Kress and the Commodity Round Table, which is composed of leaders of commodity groups, the Farm Bureau and others. Thus we ensured that the key voices from many regions have been heard and provided us with priority areas for us to explore during FY2021 and beyond, including:

- Economic and Workforce Development (includes technology, broadband access, and digital skills)
- Health and wellness (includes mental health, nutrition, resiliency)
- Environmental and Agricultural Sustainability (includes climate mitigation/adaptation, water, food production, and food security)
- Community development and capacity building (includes leadership development and convening)
- Family, parenting, and 4-H youth development
- Diversity, equity, and inclusion (includes reaching underserved)
- Financial Management (includes financial literacy and resource management)

Highlighted Results by Project or Program

Critical Issue

OSU - Economic Vitality

Community Economics: Ohio Business Retention and Expansion (BRE) Program

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7002736



Community Economics: Ohio Business Retention and Expansion Program 2021 Results

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

A declining sense of social connectedness, a community's lack of understanding of its economic resources, and an ill-informed economic development plan are confronting many struggling communities in today's rapid societal and economic change. Many local governments are left with decreasing revenue streams, vacant buildings, and high unemployment rates.

A healthy and vibrant local economy depends on the well-being of local businesses. Local business health can be fostered via a community-led Business Retention and Expansion (BRE) Program.

A BRE program involves a dialogue with local businesses to better understand their issues and concerns. Such efforts can show the community's appreciation for business contributions and enable local leadership to identify economic development strategies informed by local business as well as inform the community at large about individual and community-wide business concerns.

Communities that actively implement an on-going BRE program focusing on the retention and expansion of local businesses will:

- Improve the business climate of the community
- Help to make local businesses remain competitive
- Increase employment
- Stabilize the local economy

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 Business Retention and Expansion (BRE) Program facilitates improved relationships among local development organizations and business leaders. This collaboration can lead to more effective communications and long-term working partnerships resulting in more cooperative community policy and decision-making.

BRE provides the resources, training, and tools to develop the capacity of the community to better understand its economy. In addition to enhanced community capacity to address critical community issues, other outcomes of such community engagement include a streamlined BRE process that enables local leaders to focus on planning, action and results; a database of local information; and a more robust local economy.

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

To help local leaders gain a better understanding of issues related to their economy, the Ohio Business Retention and Expansion (BRE) program provides a structured approach to assessing and addressing business needs. Community input was collected and compiled and formatted as a reference to better inform local decision making.

In 2021, there were 10 community surveys conducted. More than 500 individuals participated in the BRE program in 2021. Participants indicated an improved working relationship because of meeting more regularly to discuss community and economic development issues. Combined and as a result of the program, six new businesses were created; five new business plans were developed, 246 jobs were created, and nearly 1800 jobs were retained.

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

The new businesses and jobs that were created and jobs that were retained; will greatly benefit the broader communities in which they are located. Created 24 economic overview reports that include relevant economic data and impacts related to county industries and occupations. 29 organizational plans were created, and 82 plans/policies adopted.

Partnership to Assist the Development of Broadband Access for Ohio Appalachian Counties

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7002740



Partnership Developed to Provide Broadband Access for Noble County Located in Appalachia – 2021 Results

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

Today, technology plays a pivotal role in how businesses operate, how institutions provide services, and where consumers choose to live, work, and play. The success of a community has become dependent on how broadly and deeply the community adopts technology resources, which includes access to reliable high-speed networks, the digital literacy of residents, and the use of online resources locally for businesses, government, and leisure. Communities, particularly those in rural areas like Noble County, struggle with economic recession, attrition, disinvestment, apathy, and overall community decline.

Access to affordable broadband will also be a key issue in this area. The unemployment rate in Noble County was 7.2% in December 2019 (the most recent data from the United States Federal Reserve). By comparison, the unemployment rate across Ohio for this time period was 4.2%. Historically, unemployment rates in Noble County reached a record high of 20.6% in December 2010 and are consistently above the national average.

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 Noble County, OSU Extension Community Development (CD) provided guidance, project management, and grant writing to enhance broadband access with 92% of the populated area and 62% of households not having access to minimum internet speeds. A \$50,000 technical assistance grant from The Appalachian Regional Commission with \$21,500 in matching funds from OSU Extension was implemented.

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

The broadband analysis utilized speed tests, address points and existing middle mile infrastructure, as well as areas that were bid through the federal Rural Development Opportunity Fund for broadband deployment. Six total project areas were identified, one was selected to seek additional public funding for implementation through the Ohio Governor's Office of Appalachia "distressed" broadband funding. Noble received a \$750,000 grant with local match of \$150,000 from local county ARPA funding. The second was selected by an ISP for application to NTIA.

Washington Electric Cooperative received a \$1.5 million ARC POWER grant matched with \$600,000 for its \$2.1 million Noble County grid modernization and make-ready for broadband deployment to upgrade 215 miles of main-line electrical routes and enable an ISP to cost effectively deploy fiber along the sparsely populated routes in the southern portion of Noble. Total planning and funding impact was \$3,271,500 across 259 miles serving an estimated 1,500 households.

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

OSU Extension is working collaboratively with county commissioners and the Governor's Broadband Ohio office to explore how to best identify broadband needs and solutions across Ohio. In particular, we are sharing our knowledge related to current and future farm technology needs and how broadband can contribute to a more competitive agricultural sector in Ohio.

Closing Out (end date 09/07/2023)

[Behavioral economics and the intersection of healthcare and financial decision making across the lifespan](#)

Project Director

Lauren Jones

Organization

Ohio State University

Accession Number

1019233



Annual Progress Report

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

The answer to this question will help researchers and policy-makers measure the true value of the EITC program. It will also help policy-makers understand the health impacts of cash transfer policies as compared to other potential health-improving policy tools, such as public health insurance plans like Medicaid. The results of this project will guide allocation of scarce

public resources to help efficiently combat health disparities across the income spectrum.

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 research team has been actively conducting analyses of our main secondary dataset, the National Longitudinal Survey of Youth 1979 cohort (NLSY79). These data track a sample of nearly 4,000 women born between 1957 and 1964, living across the US. Every year, the survey asks respondents about their finances, fertility and health. Using these data, we have related a measure of exposure to the EITC policy to health outcomes measured at age 50. Using research methods that allow us to identify causal effects of the policy, I have produced estimates that capture how raising children in an era with more generous income-support policy affects health at age 50. The results have revealed that exposure to more generous EITC over one's life is related to improved physical health at age 50, with reduced incidence of activity limiting physical health issues (i.e. difficulty climbing stairs, etc.) and reduced diagnoses of cancer and lung issues.

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

Women who receive the EITC during their child-bearing years are generally low-income, more likely to work as low-skilled labor and more likely to be single mothers. This is a population that is disproportionately affected by negative health impacts. The findings of this study suggest that the EITC – a major anti-poverty policy tool of the federal government – has significantly improved physical health among this vulnerable population in the long-term. These results add to the literature showing that the EITC has benefited women across the country.

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

The results of this study demonstrate that the EITC may generate cost-savings to the federal government and taxpayers by reducing the onset of costly disease later in life. Because healthcare among Americans over age 65 is publicly funded, these cost savings accrue to taxpayers, and generate healthcare cost savings for the economy at large. Additionally, many low-income families are tasked with providing their own care for ailing relatives, since we do not presently have widely accessible public options for long-term care for sick or elderly available. This often leads family members to reduce work in order to provide care. Thus, staving off illness in old age also benefits family members, and the larger workforce, by reducing long-term care needs.

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 has resulted in a forthcoming publication (citation below). One co-author (Guangyi Wang) was a PhD student research assistant. She is now a post-doctoral fellow at the Philip R. Lee Institute for Health Policy Studies at University of California, San Francisco. Moving into the final reporting period of this project, I will be submitting an NIH grant proposal based on this research focused on identifying racial differences in the impact of the EITC on health and work outcomes.

Jones, L. Wang, G., & Yilmazer, T. (in press). The Long-term Effects of the Earned Income Tax Credit on Women's Physical and Mental Health. *Health Economics*.

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.

Dr. Lauren Jones is working to help researchers and policy makers measure the true value of the Earned Income Tax Credit (EITC), one of the largest anti-poverty programs in the United States. This program benefits underserved and under-represented populations such as disabled individuals and low-income, working parents. The EITC provides significant income support to low- and medium-income working families with eligible children. Since its inception in 1975, the credit has been expanded significantly, especially for larger families and families living in certain states. A long line of literature has demonstrated positive effects of the policy on short-term outcomes but little was known about the long term effects. Dr.

Jones hypothesized that there may be long term health effects from the policy since the increase in income can lead to increased funds for healthy food, health care and lower stress levels. She and her team were able to study survey answers by a cohort of women born between 1957 and 1964 to determine their health outcomes at age 50. They found that a more generous EITC during one's life is related to improved physical health at age 50, with reduced incidence of physical health issues and reduced diagnoses of cancer and lung issues. Reducing the onset of disease until later in life will reduce healthcare costs for the economy at large since healthcare among Americans over age 65 is publicly funded.

Enhancing Rural Economic Opportunities, Community Resilience, and Entrepreneurship

Project Director

Mike Betz

Organization

Ohio State University

Accession Number

1018820



Enhancing Rural Economic Opportunities, Community Resilience, and Entrepreneurship

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

Many rural areas lag urban areas in across many indicators of economic vitality. Diverging incomes, labor market opportunities, and quality of life between rural and urban areas can lead to undesirable outcomes nationally and suboptimal resource allocation that leave both rural and urban areas worse off. Yet, much is unknown regarding rural/urban interdependence and optimal policy formation that benefits both rural and urban areas. Our project seeks to create and disseminate new knowledge concerning these issues.

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.

I currently have two research projects related to this project's goals. First is a project that aims to determine the economic and demographic impacts of shale oil and gas drilling in the communities which it occurs. This project created new knowledge with regard to understanding how oil and gas activities have impacted human capital formation decisions of those living in drilling communities and how those communities aggregate human capital is impacted by migration decisions. The second project seeks to better understand economic and contextual factors in rural areas impact drug overdose deaths. I also began work at the intersection of these two areas identifying the role of oil and gas activity on overdose death rates in rural areas.

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

The results of my research a salient for community leaders trying to understand how oil and gas activities in their communities will impact local economic and demographic trends. Specifically, my research found that rural areas with greater oil and gas activities attracted migrants with lower average education levels than those with no oil and gas activity, all else equal. Additionally, outmigrants from rural communities with more oil and gas activity had had higher average education levels than outmigrants from non-drilling communities. I also created new knowledge regarding the impact of oil and gas on overdose drug deaths, finding that greater oil and gas activity led to higher overdose death rates, particularly for male working age individuals. These findings provide rural community leaders with better information about the impacts of oil and gas activity in their communities.

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

Our findings regarding the impact of oil and gas development have implications for the broader public. As the public makes decisions about our nation's energy future and which fuels to use in electricity generation and home heating, the full range of costs and benefits must be considered. Understanding how domestic oil and gas production may impact longer-term human capital decisions have implications for the long-term viability of rural extraction communities. This is especially true given the boom/bust nature of the industry. Our work better elucidates those costs that might not otherwise be fully accounted for in considering the future of energy production in the United States.

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.

Co-Project Directors are Mark Partridge and Elena Irwin - AEDE - The Ohio State University

Abboud, A., & Betz, M. R. (2021). The local economic impacts of the oil and gas industry: Boom, bust and resilience to shocks. *Energy Economics*, 99, 105285.

Partridge, M., Tsvetkova, A., & Betz, M. (2021). Are the most productive regions necessarily the most successful? Local effects of productivity growth on employment and earnings. *Journal of Regional Science*, 61(1), 30-61.

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

Project Director

Brent Sohngen

Organization

Ohio State University

Accession Number

1018566



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

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

This research is Ohio's contribution to a regional research project with twenty-one states involved. Objectives are to estimate the economic benefits of ecosystem management of forests and watersheds; estimate the economic value of changing recreational access for motorized and non-motorized recreation; calculate the benefits and costs of agro-environmental policies; and estimate the economic values of agricultural land preservation and open space.

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.

Under Resource Management

- 1) D. Miteva contributed to our understanding of how protected areas can slow deforestation and provide incentives for resource conservation in regions where decisions are decentralized from central government control.
- 2) B. Sohngen and colleagues published a paper that updated current estimates of the costs of carbon sequestration in agriculture, forest and other land uses. Sohngen also worked with colleagues at PIK-Potsdam to include forests in the global integrated assessment model MAGPie. Finally, Sohngen and colleagues examined how climate change influences forest stocks globally over time through disturbances and changes in growth.
- 3) Y. Cai and colleagues showed how forest losses could influence local climate in the United States.

Under Economic valuation:

- 1) T. Haab and colleagues have written an article for the Oxford Research Encyclopedia that establishes the state of the art in contingent valuation methods and approaches.
- 2) H Klaiber developed novel valuation techniques to estimate welfare effects using sorting models with residential data. He applied these techniques to noise pollution in a European context, and water quality changes in the US.
- 3) B. Sohngen worked with F. Lupi at Michigan State University to present two papers on Lake Erie beach valuations resulting from a survey developed and conducted jointly by Ohio State U and Michigan State U.

Under Integrated Policy and Decision Making

1) Dr. Cai summarize the state of science on the role of uncertainty in economic models of decision making especially for decisions involving climate change policy.

4) S Gopalakrishnan summarized the literature and state of economic science on assessing the effects of climate change on coastal resources, helping policy makers better design policies and programs to assist landowners in adapting to climate change.

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

State and federal policy makers: US EPA and US Department of State used estimates of carbon sequestration developed by Sohngen to set the US Nationally Determined Commitment to the Paris Agreement. They used estimates for other countries to negotiate with those countries. Results have been used in the Intergovernmental Panel on Climate Change report. Federal policy makers used methods developed by Yongyang Cai to calculate the social cost of carbon in the Interagency Working Group Report on the social cost of carbon. Federal policy makers have used work by S. Gopalakrishnan to develop climate adaption plans for coastal areas.

Non governmental organizations: Numerous agencies used work by D. Miteva on deforestation in developing international policies to slow deforestation. They have used estimates of the cost of carbon sequestration in agriculture and forests by Sohngen to help educate farmers and landowners about the value of their carbon resources.

The environmental and natural resource research community has benefited from this research as evidenced by the 2528 Google Scholar citations for the individuals on the project.

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

The broader public has benefited from the research which provides access to economic values for ecosystem service flows. Important flows we have valued are

- 1) Carbon storage in forests and agricultural soils
- 2) Water quality improvements, including reductions in the impacts of harmful algal blooms
- 3) Coastal resources
- 4) Forest biodiversity
- 5) Noise pollution

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.

Participants:

B. Sohngen, T. Haab, A. Klaiber, S. Gopalakrishnan, D. Miteva, Y Cai

Publications:

Miteva D.A. and S.K. Pattanayak. (2021). "The effectiveness of protected areas in the context of decentralization". *World Development* 142: 105446.

Chen, W, J.E. Flatnes, D.A. Miteva, H.A. Klaiber. (2021). "Impact of deforestation on ecotourism: Evidence from citizen-science bird-watching data in Mexico". *Land Economics*. <http://le.uwpress.org/content/early/2021/10/13/le.98.1.031020-0036R1.abstract>

Klaiber, HA and Morawetz, UB. "The Welfare Impacts of Large Urban Noise Reductions: Implications from Household Sorting in Vienna." *ENVIRONMENTAL AND RESOURCE ECONOMICS*. Vol 78 (1): 121-146. 2021.

Dong*, X and Klaiber, HA. "Local Brand Entry and Incumbent Variety Response: Evidence from the Ice Cream Market." *AGRICULTURAL AND RESOURCE ECONOMICS REVIEW*. Vol 50 (2): 296-314. 2021.

Towe, C, Klaiber, HA, Maher, J., and Georgic*, W. "A Valuation of Restored Streams Using Repeat Sales." *ENVIRONMENTAL AND RESOURCE ECONOMICS*. Vol 80: 199-219. 2021.

Livy*, MR and Klaiber, HA. "Equilibrium Outcomes and Amenity Valuation in a Multi-Spatial Residential Sorting Framework." *LAND ECONOMICS*. Vol 97 (3): 509-527.

Li, Yang, Yanlan Liu, Gil Bohrer, Yongyang Cai, Tongxi Hu, Zhihao Wang, and Kaiguang Zhao (2022). Impacts of Forest Loss on Local Climate across the Conterminous United States. *Science of the Total Environment*, 802, 149651 (19 pages). <https://doi.org/10.1016/j.scitotenv.2021.149651>

Cai, Yongyang (2021). The role of uncertainty in controlling climate change. *Oxford Research Encyclopedia of Economics and Finance*. Oxford University Press.

<https://doi.org/10.1093/acrefore/9780190625979.013.573>

Favero, A., Mendelsohn, R.O., Sohngen, B. and Stocker, B., 2021. Assessing the long-term interactions of climate change and timber markets on forest land and carbon storage. *Environmental Research Letters*. 16(1), p.014051

Mishra, A., Humpenöder, F., Dietrich, J.P., Bodirsky, B.L., Sohngen, B., Reyer, C.P., Lotze-Campen, H. and Popp, A. 2021. Estimating global land system impacts of timber plantations using MAGPIE 4.3. 2. *Geoscientific Model Development Discussions*. 14(10): 6467-6494

Roe, S., C. Streck, R. Beach, J. Busch, M. Chapman, V. Daioglou, A. Deppermann, J. Doelman, J. Emmet?Booth, J. Engelmann, J., O. Fricko, C. Frischmann, J. Funk, G. Grassi, B. Griscom, P. Havlik, S. Hanssen, F. Humpenoder, D. Landholm, G. Lomax, J. Lehmann, L. Mesnildrey, GJ Nabuurs, A. Popp, C. Rivard, J. Sanderman, B. Sohngen, P. Smith, E. Stehfest, D. Woolf, D. Lawrence. 2021. Land?based measures to mitigate climate change: Potential and feasibility by country. *Global Change Biology*. 27(23): 6025-6058. DOI: 10.1111/gcb.15873

Sohngen, B. 2021. Forest Management and Trade for Forest Products. Chapter 3 in *Latin American and Caribbean Forests in the 2020s: Trends, Challenges, and Opportunities*. Edited by A. Blackman. IDB-MG-864. Washington: Inter-American Development Bank. 205 p.

Wolf, D., Klaiber, H.A., and Gopalakrishnan, S. "Staying afloat: The effect of algae contamination on Lake Erie housing prices", 2022, Forthcoming, *American Journal of Agricultural Economics*

Li, Xiaoyu and Gopalakrishnan, S., "Climate Change and Coastal Vulnerability", 2021 *Oxford Research Encyclopedia of Economics and Finance*. Oxford University Press. doi: 10.1093/acrefore/9780190625979.013.576.

John C. Whitehead & Andrew Ropicki & John Loomis & Sherry Larkin & Tim Haab Sergio Alvarez, 2021. "Estimating the Benefits to Florida Households from Avoiding Another Gulf Oil Spill Using the Contingent Valuation Method: Internal Validity Tests with Probability-based and Opt-in Samples," Working Papers 21-13, Department of Economics, Appalachian State University.

Haab, Timothy, 2021 (forthcoming), "Principles for Teaching the Principles of Environmental Economics," *Teaching Environmental and Natural Resource Economics: Paradigms and Pedagogy*, Edward Elgar, UK.

Haab, Timothy, Lynne Lewis, and John Whitehead, 2020, "State of the Art of Contingent Valuation," *Oxford Research Encyclopedia of Environmental Science*, Oxford University Press, UK.

Presentations:

Boudreaux, GL, F Lupi, B Sohngen, AY Xu. 2021. Great lake beach visitor preferences toward harmful algal bloom and bacterial warnings. Selected Presentation. Annual Meetings of the Agricultural and Applied Economics Association. Austin, TX, August 2021.

Liu, B, B Sohngen, and JS Baker. 2021. Dynamics and investments in forest carbon leakage. Selected Presentation. Annual Meetings of the Agricultural and Applied Economics Association. Austin, TX, August 2021.

Boudreaux, GL, F Lupi, B Sohngen, AY Xu. 2021. Estimating economic damages of water quality warnings in the Great Lakes. Poster Presentation. Annual Meetings of the Agricultural and Applied Economics Association. Austin, TX, August 2021.

Parisa, Z., E. Marland, B Sohngen, G. Marland. 2021. Achieving "permanence" with short-term, high-magnitude carbon sequestration forests. Poster Presentation. American Geographical Union Fall Meeting. December, 2021.

Sohngen, B. 2021. Can the world really get 5 – 8 billion tons of CO₂ mitigation from forests in the next 30 years? Keynote presentation. Ulvon Conference, sponsored by the Center for Environmental and Resource Economics at the University of Umea and the Swedish University of Agriculture (SLU). August, 2021.

Gopalakrishnan, S., Xiaoyu Li and H. Allen Klaiber 'Local Adaptation and Unintended Vulnerability: The effect of coastal hazards and adaptation on residential development', Online Agricultural and Resource Economics Seminar (OARES), October 27, 2021, Virtual (w/)

Gopalakrishnan, S., Xiaoyu Li and H. Allen Klaiber. 'Local Adaptation and Unintended Vulnerability: The effect of coastal hazards and adaptation on residential development', University of Delaware, Marine Science and Policy Colloquium, October 20, 2021, Virtual.

Gopalakrishnan, S. David Wolf and H. Allen Klaiber. 'Seeing is Believing: Non marginal impact of water quality change', June 11, 2021, Department of Applied Economics, Oregon State University, Virtual. (with David Wolf and H. Allen Klaiber)

Miteva, D. Triangle Resource and Environmental Economics (TREE) seminar (2021), online

Miteva, D. European Association of Environmental and Resource Economists annual meeting (2021), online

Miteva, D. Department of Natural Resources Management seminar, Texas Technical University, TX (2021), online

Miteva, D. "Planning for sustainable development", Sustainable Agriculture for Biodiversity and Habitat Conservation workshop, Bulgaria (2021), online

Cai, YY. Economic implications of multiple interacting tipping points. OECD Expert Workshop Economic Modelling of Climate and Related Tipping Points, OECD (virtual workshop), October 2021. (The video is available online: <https://www.youtube.com/watch?v=7IBG8GBp6mY>)

Cai, YY. The social cost of carbon with economic and climate risks. Economics and Management School, Wuhan University, July 2021.

Cai, YY. Capital stocks and climate policy: The discussion of carbon taxes' role. School of Public Finance and Taxation, Southwestern University of Finance and Economics (virtual talk), July 2021.

Cai, YY. Climate Change Impact on Economic Growth: Regional Climate Policy under Cooperation and Noncooperation. The 26th EAERE Annual Conference (virtual sessions), June 2021.

Cai, YY. Climate Policy under Spatial Heat Transport: Cooperative and Noncooperative Regional Outcomes. The 2021 North American Summer Meetings of the Econometric Society (virtual sessions), June 2021.

Cai, YY. Climate Policy under Spatial Heat Transport: Cooperative and Noncooperative Regional Outcomes. Center for Energy & Environmental Policy Research, Beihang University (virtual talk), December 2020.

Cai, YY. Climate Policy under Spatial Heat Transport: Cooperative and Noncooperative Regional Outcomes. Center for Energy and Environmental Policy Research, Beijing Institute of Technology (virtual talk), November 2020.

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.

Dr. Brent Sohngen leads Ohio State's [Environmental Policy Initiative](#), which stimulates and focuses systematic collaboration in environmental policy nationally and internationally. His research focuses on the economics of land use change, the design of incentive mechanisms for water and carbon trading, carbon sequestration, and valuation of environmental resources. Sohngen has been helping to educate farmers and landowners about the value of their carbon resources. Carbon markets have emerged in recent years as large international companies have vowed to offset the carbon dioxide they put out in emissions from producing and transporting products. That can be done by paying farmers and foresters to take measures that store more carbon in plants and soil through activities such as starting no-till farming, planting cover crops or trees and more intensively managing existing forests. "I think it's something that's emerging," Sohngen said of carbon markets. "Within a decade, I wouldn't be surprised to see 20% to 40% of Ohio farmers involved in a contract."

Critical Issue

OSU - Environmental Quality and Sustainability

[Pesticide Safety Education Programs for Commercial and Private Applicators](#)

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7002753



[Pesticide Safety Education Programs for Commercial and Private Applicators - 2021 Results](#)

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

Pesticide application businesses, public agencies, and farms need to manage pests safely and effectively. Employers need employees who are licensed, trained in best management practices, and current with state and federal regulations. The commercial and private pesticide applicators require continuing education to maintain their license and livelihoods.

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.

Pesticide Safety Education Programs (PSEP) offered pesticide exam preparation workshops to 224 new commercial pesticide applicators. In addition, 267 new wood destroying insect inspectors were trained. Continuing education programs were provided to 3,530 commercial pesticide applicators to assist them in meeting requirements under Ohio pesticide law. Approximately 25 state Extension specialists and county educators contributed their expertise to the recertification programs. Nearly 60 percent of these applicators (n=2,052) took the self-paced online recertification course.

Through recertification programs, PSEP provided research-based recommendations and best practices training for commercial applicators. PSEP also provided in-service training and teaching resources for county educators to help them prepare for county pesticide applicator meetings; 4,239 private applicators recertified through participation in more than 100 county meetings in 2021.

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

Commercial applicators attending recertification programs agreed they had learned how to control pests more effectively (94%) and were better informed how to comply with pesticide and environmental regulations (95%). For those attending county meetings, more than 92% agreed they had learned how to apply pesticides more safely, had improved practices to protect the environment, and controlled pests more effectively. Each private and commercial applicator attending in-person recertification programs in 2021 received an OSU Extension publication with current pest management recommendations.

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

One of the long-term goals of the PSEP is to reduce run-off of pesticides thereby helping to improve water quality in Ohio.

Water Quality Education

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7002760



Water Quality Education – 2021 Results

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

Ohio has 125,000 lakes, reservoirs, and ponds as well as 60,000 miles of rivers and streams. Water quality issues such as harmful algal blooms in Lake Erie caused by phosphorous run off from farms are a serious concern for the state.

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.

OSU Extension has trained farmers about water pollution and the connections between production practices and environmental stewardship. Through Cargill's and the Natural Resources Conservation Service's support, water quality associates with OSU Extension have made more than 500 contacts with farmers and 300 on-farm site visits.

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

Part of the team's work involves running field trials to determine the effects of applying varied rates of phosphorus, nitrogen, and potassium fertilizers to cropland. Extensive soil testing has been done on fields to see how planting cover crops and minimally tilling the land affects soil health. New water quality monitoring stations have been set up to show trends in nutrient runoff rates.

Drone-assisted projects have saved local partners approximately \$40,000 by providing 115 free flights covering more than 1,400 air miles. In 2021, these projects included:

- the development of an Ohio cover crop database.
- a drainage tile mapping project that is using multispectral and thermal imagery to map tile lines in different soils and management practices; and to map thermal differences in water in ditches to locate tile drains.
- a cover crop biomass/nitrogen-uptake study.
- a multispectral drone and in-field biomass evaluation that is comparing manure versus commercial fertilizer.

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

Education from the OSU Extension Water Quality team does not stop at the farmer level. All Water Quality Wednesday Webinars, as well as water-quality focused Extension events are open to the public. In addition, the team has collaborated with two municipalities on drinking water monitoring to improve the quality of the cities' water for the general public. A new water quality Extension website was also created to provide easy access to water quality related information and programming to Ohioans and beyond. waterqualityextension.osu.edu

Improving techno-economics and emissions of feedstock supply systems for biobased industries

Project Director

Ajay Shah

Organization

Ohio State University

Accession Number

1021119



Improving techno-economics and emissions of feedstock supply systems for biobased industries

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

Costs and emissions are two major limiting factors for sustainable production of bioproducts and renewable fuels. We have analyzed the costs and emissions for (1) logistics of different feedstocks, including corn grain, corn stover, miscanthus, pennycress (an oilseed), *Taraxacum kok-saghyz* (an alternative rubber crop) and hemp, and (2) converting biomass feedstocks and wastes to bioproducts (lactic acid) and renewable fuels (jet fuel, bio-oil, fuel pellets).

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 presented three practical strategies that could be implemented in the near term to improve the performance of the corn stover supply chain and reduce overall cost, energy use, and greenhouse gas emissions on an average, by 34–35% from the current average benchmarks. Techno-economic analysis was performed for supplying corn stover and miscanthus for a lactic acid biorefinery, which indicated lower biomass production and logistics costs for miscanthus, owing to its higher biomass yield.

Techno-economic and life cycle analyses of lactic acid production from corn grain, corn stover and miscanthus through three fermentation pathways, including bacteria, fungi and yeast, was conducted. Our study found that the total lactic acid production costs for all feedstocks and through different pathways were comparable to lactic acid produced from petroleum. The global warming potential (GWP) for biobased lactic acid produced through different pathways were 63-88% lower than that for petroleum based. Improvement of process efficiencies and identification of microorganisms that can withstand the acidic fermentation conditions can lower the costs and environmental impacts of lactic acid production.

The costs and GWP of renewable jet fuel production from pennycress seeds was also estimated. Minimum selling price of renewable jet fuel was comparable to those produced from similar oilseeds, including soybean and canola. GWP of pennycress-based renewable jet fuel was also lower than those produced from similar oilseeds and the commercial jet fuel baseline. The minimum selling price and GWP could be further reduced by supplying pennycress grain at a lower price, increasing the pennycress seed yield and oil content, and increasing the production capacity of the biorefinery.

Techno-economic analysis was conducted for hemp production and processing for grain, Cannabidiol (CBD) and fiber. Based on the market prices, net revenues for CBD oil were much higher than that for grain, and fiber-based products. However, there are high fluctuation in the CBD oil prices compared to grain and fiber-based products. Thus, stable market prices for hemp fiber and grain products compared to CBD oil make them low-risk alternatives for farmers.

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

The project activities evaluated the costs and emissions of producing different bioproducts and biofuels using biomass feedstocks. The findings were published in peer-reviewed journals and presented at the local, regional and international conferences and shared with researchers and relevant stakeholders, such as biobased product and energy companies, and commodity groups. Multiple parties interested in establishing biobased industries using different feedstocks from different parts of the world contacted us and benefitted from our discussions and insights on their commercial operation feasibility.

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

Our analysis identified the commercial scale feasibility, costs and environmental impacts of lactic acid and renewable jet fuel production systems from biomass feedstocks. Our study identified the bottlenecks for procuring and converting biomass feedstocks to the selected products at commercial scale. The methodology implemented in the analysis also provided guidelines to conduct techno-economic and life cycle analyses of other new biobased systems.

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.

- 2 Postdocs, 2 Ph.D. Students and 1 M.S. Student were trained on conducting techno-economic and life cycle analyses of biobased system and have presented their research findings at various professional conferences.

- The findings were presented at the local, regional and international conferences and shared with researchers and relevant stakeholders, such as biobased product and energy companies, and commodity groups.

- We will continue analyzing techno-economic and life cycle environmental impacts of different biobased products and fuels from different biobased feedstocks.

- There was no formal co-PI on the project. However, for different projects, we collaborated with the researchers and stakeholders from different departments from OSU and the other institutions and industries.

Journal papers

1. A. Khanal, A. Manandhar, S. Adhikari, A. Shah. 2021. *Techno-economic analysis of novolac resin production by partial substitution of petroleum-derived phenol with biooil phenol*. Biofuels, Bioproducts and Biorefining 15(6):1611-20. <https://doi.org/10.1002/bbb.2268>

2. S.H. Mousavi-Avval, A. Shah. 2021. *Techno-economic analysis of hydroprocessed renewable jet fuel production from pennycress oilseed*. Renewable and Sustainable Energy Reviews 149: 111340. <https://doi.org/10.1016/j.rser.2021.111340>

3. S.H. Mousavi-Avval, A. Shah. 2021. Life cycle energy and environmental impacts of hydroprocessed renewable jet fuel production from pennycress. Applied Energy 297: 117098. <https://doi.org/10.1016/j.apenergy.2021.117098>.

4. A. Shah, A. Manandhar, M. Darr. 2021. *Near-term practical strategies to improve the life cycle techno-economics, energy use and greenhouse gas emissions of corn stover supply system for biobased industries*. Biofuels, Bioproducts and Biorefining 15(3):793-803. <https://doi.org/10.1002/bbb.2199>

Presentations

1. H. Stockham, A. Khanal, A. Shah. 2021. *Techno-economic analysis of co-pelletization of agricultural residue and plastic waste for cement production*. ASABE Annual International Meeting 2021, July 12-16. Virtual. [Poster]

2. A. Khanal, A. Shah. 2021. *Techno-economic analysis of hemp production and logistics in the U.S.* ASABE Annual International Meeting 2021, July 12-16, Virtual. [Oral]

3. A. Manandhar, S. Khanal, A. Shah. 2021. *Techno-economic analysis of implementing UAV technologies for crop health monitoring.* ASABE Annual International Meeting 2021, July 12-16, Virtual. [Oral]

4. A. Manandhar, S. Khanal, A. Shah. 2021. *Techno-economic analysis of implementing unmanned aerial systems for corn crop health monitoring.* The CFAES Annual Research Conference, April 8, virtual. [Poster]

5. A. Khanal, A. Shah. 2021. *Techno-economic comparison of hemp production and processing for grain, Cannabidiol (CBD) and fiber.* The CFAES Annual Research Conference, April 8, virtual. [Poster]

Closing Out (end date 09/07/2023)

Future Challenges in Animal Production Systems: Seeking Solutions through Focused Facilitation

Project Director

Lingying Zhao

Organization

Ohio State University

Accession Number

1017546



Future Challenges in Animal Production Systems: Seeking Solutions through Focused Facilitation

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

The animal production industries significantly contribute to the U.S. economy. However, air pollutant emissions associated with animal production cause significant environmental concerns. For examples, dust emission from poultry facilities presents animal health, occupational safety and health, and food safety concerns. Ammonia (NH₃) emission from animal farms contributes 80% of the total anthropogenic NH₃ emissions to the atmosphere in the U.S. and represents a significant stress to the ecosystems. Tools and solutions to understand and mitigate the concerns are needed to help the animal industries in developing sustainable animal production systems.

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.

My efforts fitting into the objectives of multi-state project S-1074 have been focused on developing model tools to estimate air emission generation, distribution, and dispersion, and air emission mitigation technologies. In 2021, we have been working on two projects.

Project 1: A NIFA Foundational grant project "Modeling Fluxes, Fate and Transport of Ammonia Emission from Egg Production and Manure Management Facilities".

- AERMOD simulations were developed for estimation of dispersion and deposition of NH₃ emission from typical manure-belt layer facilities in Ohio.
- Field measurement campaigns for NH₃ dispersion were conducted in a commercial manure-belt layer farm in August and October of 2021. Extensive data on ammonia emission rates from various type of the poultry layer facilities, including production houses, manure composting facilities, manure storages, and waste water processing lagoons, were successfully obtained. Ammonia concentration data at upwind location and 20 downwind locations over 10 days were collected along with the on-site weather condition data.

- The AERMOD model was validated using the data collected from field measurement.

- Equipment and methods for field measurement of low level of ammonia were investigated.

Project 2. A NIFA grant project “Electrostatic Precipitation for Air Cleaning of Particulate Matter (PM) Emissions at Animal Production Facilities.”

- We primarily conducted field performance tests of electrostatic precipitator (ESP) and electrostatic spray scrubber (ESS) prototypes for dust control and pathogen deactivation at poultry layer houses. Materials and energy costs of the ESP and ESS operations were recorded. Techno-economic analyses for both the optimized ESP and ESS devices were conducted based on the long-term field test data. A Ph.D. dissertation on mitigation of dust emission at poultry layer facilities using ESP and ESS had been finished in 2021. A M.S. graduate study on control of pathogens using the ESP and ESS devices had also been started in 2021.
- A journal article on a COMSOL computer simulation model to simulate and optimize electrostatic precipitators (ESPs) for collection of dust particles has been published.
- A journal article on optimization of ESS has been submitted.
- An extension workshop on PM control at poultry facilities using electrostatic precipitation technologies has been developed and will be offered at the 2022 Waste to Worth Conference in April, 2022.

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

The targeted audiences are peer researchers, university faculty, graduate students, livestock and poultry professionals and animal producers.

- The project results have been disseminated through in-person meetings among the team members and with the professionals and managers of the collaborating farm – New Day Farms, LLC.
- The project results have been disseminated through publications of several journal papers and conference presentations, and popular press articles. See the publication section for details.
- An extension workshop on the results has been developed and will be offered the 2022 Waste to Worth Conference in April, 2022 and then through on an online platform.

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

- The outcomes of the Project 1 include a fundamental mechanistic air emission model (AEM), a farm-scale, processed-based AEM, and the dispersion model AERMOD for NH₃ emissions from poultry facilities and subsequent transport and deposition. These decision support tools for the animal industries and governmental agencies are expected to enable fair assessment and effective control of NH₃ emissions for improved health of public, farm worker, and animals. In addition, the outcomes will contribute to sustainable egg production and agroecosystems.
- The outcomes of the Project 2 include effective and economically feasible PM control technologies that will enable the poultry industry to effectively mitigate PM emissions, which will result in improved One Health (health of people, animal, plant, and the environment), reduced outbreaks of foodborne diseases, reduced losses due to outbreak of infectious disease in poultry production, enhanced environmental quality, and sustainable animal production. The project will also contribute innovative PM control solutions for a competitive and sustainable egg production industry in the U.S.

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.

- Describe and explain any major changes or problems encountered in approach.
 - Covid-19 pandemic and the associate lockdown has significantly delayed the field tests in early month of 202, but we were able to finish the majority of field tests in fall of 2021 with an NIFA approved no-cost extension of the projects.

- Additionally, note opportunities for training and professional development provided,
 - The PI attended the S-1074 project seminars, the annual meeting, and grant proposal discussions online meetings.

 - The graduate student and postdoctoral research associate participated AERMOD modeling trainings offered by The Lakes Environmental Software (<https://www.weblakes.com/>).

 - They presented the research results at professional conferences through Zoom or recorded presentations

 - Among the research group, a collaboration between researcher from North Carolina State University and The Ohio State University, various internal trainings on how to use difference measurement equipment and different modeling tools were conducted.

- how results have been disseminated to communities of interest, and
 - See above the related section

- any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.
 - We will continue to participate the S-1074 seminars /workshops to establish networks and collaboration with other members of the S-1074 multi-state project. Seek proposal collaboration opportunities with the S-1074 members.

 - We have finished Project 1, but will continue to publish the research work on using AERMOD model for estimation of ammonia dispersion from poultry production facilities and a PALM model for simulations of dispersion and deposition of NH₃ emission from poultry facilities in collaboration with Dr. Gil Bohrer.

 - We have finished field tests for Project 2. We will continue to analyze the field test data and publish the lab performance test and field test results as journal articles. The project will be finished in April 2022.

 - More proposal writing opportunities will be developed in collaboration with other S-1074 project members or peers.

- Update University approvals, IRB
 - N/A

- Include the names, departments of CO-PIs that contributed.

Heping Zhu (PhD)

Agricultural Engineer

Application Technology Research

heping.zhu@usda.gov

Phone: (330) 465-4101

Jiyoung Lee, PhD

Professor

Environmental Health Sciences

Email: lee.3598@osu.edu

Phone: 614-292-5546

Gil Bohrer

Professor

Department of Civil, Environmental and Geodetic Engineering, The Ohio State University

405 Hitchcock Hall, 2070 Neil Ave, Columbus, OH 43210,

Phone: 614-292-4178, Fax: 614-292-3780

E-mail: bohrer.17@osu.edu

Jiqin Ni

Associate Professor

Agricultural & Biological Engineering

Purdue University

jiqin@purdue.edu

+1 765 49-61733

Albert Heber, Ph.D., P.E.

Professor Emeritus

Agricultural & Biological Engineering

Purdue University

heber@purdue.edu

Phone: (765) 494-1214

- At this time place your publications

1. Jepsen, L.Y. Zhao, and A. Soboyejo. 2022. Quantifying farmers' exposure to corn and soybean dust in on-farm grain storage bins. *J. of Agricultural Safety and Health*, 28 (2): xx-xx. <https://doi.org/10.13031/jash.14877>
2. Knight, R. M. L.Y. Zhao, and H. Zhu. 2021. Modelling and optimisation of a wire-plate ESP for mitigation of poultry PM emission using COMSOL. *Biosystems Engineering*, 211, 35-49. <https://doi.org/10.1016/j.biosystemseng.2021.08.026>
3. Tong, X., L.Y. Zhao, R. B. Manuzon, M. J. Darr, R. M. Knight, C. Wang, A. J. Heber, J.Q. Ni. 2021. Ammonia Concentrations and Emissions at Two Commercial Manure-Belt Layer Housed with Mixed Tunnel and Cross Ventilation. *Transactions of the ASABE*. 64(6): 2073-2087. (doi: 10.13031/trans.14634)
4. Hong, S.-w.; Park, J.; Jeong, H.; Lee, S.; Choi, L.; Zhao, L.; Zhu, H. Fluid Dynamic Approaches for Prediction of Spray Drift from Ground Pesticide Applications: A Review. *Agronomy* 2021, 11, 1182. <https://doi.org/10.3390/>
5. Knight, R., X. Tong, L. Zhao, R. B. Manuzon, M. J. Darr, A. J. Heber, J. Q. Ni. 2021. Particulate matter concentrations and emission rates at two retrofitted manure-belt layer houses. *Transactions of the ASABE*. 64(3): 829-841. (doi: 10.13031/trans.14337)

Presentation:

1. Knight, R., M. Herkins, M. and L.Y. Zhao. 2021. A Review of Electrostatic Precipitation Air Cleaning Technologies for Control of Dust Emissions and Pathogenic Bacteria at Animal Production Facilities. Presented at 2021 International Symposium on Animal Environment and Welfare, Chongqing, China, October 21-23, 2021.

Editor Reviewed Article in Popular Press

1. Zhao. L.Y. 2021. Ventilation and Control of Airborne Pathogens in Indoor Environment for Human and Animal Health. *Ohio's Country Journal*. Jun. 2021.
2. Zhao. L.Y. 2021. Ventilating Large Animal Barns in Winter for Comfort and Health. *Ohio's Country Journal*. Jan. 2021,

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 animal production industry contributes significantly to the U.S. economy and global food production. However, particulate matter (PM, also known as dust) and ammonia emissions from animal production facilities cause environmental quality and health concerns. The poultry industry contributes significantly to each of these pollutants. Dust emissions from poultry facilities can carry pathogenic bacteria and viruses, affecting the health of both animals and workers as well as the environmental quality of neighboring communities. A severe avian influenza outbreak in 2015 in the US killed more than 50 million poultry animals and scientists believe PM emissions contributed to the spread of disease. High ammonia concentrations inside poultry houses affect the respiratory and immune systems of birds, threatening viability. Once released to the outside, ammonia emissions can have negative impacts on human health and the ecosystem.

There is an urgent need to control and manage PM and ammonia emissions from poultry facilities. Dr. Zhao's team has developed electrostatic precipitators and spray scrubbers for PM mitigation in commercial poultry facilities and are currently conducting field performance tests at poultry layer houses to determine the PM removal efficiency, energy consumption and economic feasibility of these devices. They are also developing tools to estimate ammonia emission inside and downwind of poultry layer facilities for regulation and mitigation purposes as well as evaluating the efficiency of ventilation systems.

The ultimate goal of this work is to make animal production more sustainable with improved animal health, reduced disease outbreaks, and enhanced environmental quality.

Closing Out (end date 09/07/2023)

[The individual, social and institutional drivers of water quality decisions](#)

Project Director

Robyn Wilson

Organization

Ohio State University

Accession Number

1017302



2021 Annual Report

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

Our research focuses on the individual, social and institutional drivers of decision making as it relates to water quality management. Increasing our understanding of how people process complex, technical information; how individual decisions are influenced by social context; and how collaborative networks emerge enables us to encourage more informed decisions both individually and collectively. These goals are often related to more tangible outcomes in the physical environment, such as reduced nutrient loss and improved water quality.

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.

Wilson participated in several federally funded projects focused on understanding farmer conservation decisions, where several survey data sets were analyzed to develop statistical models of how farmers allocate their land to food production, energy production, and conservation given changes in economic signals; how farmers manage their land in response to variability in annual weather patterns; and what type of program design and payment might encourage farmers to set aside land for constructed wetlands. The outcomes to date for these projects are changes in knowledge, such as increased understanding of farmer heterogeneity in decision making and drivers of behavior as we analyze the survey data and work on publications.

Wilson and Toman worked with one doctoral student on a project examining the effects of financial and temporal scarcity on farmer decisions to engage in conservation behaviors. This project examined the effect of seasonal fluctuations in available time and resources on farmers and considered implications for the timing of data collection to forecast adoption rates of conservation behaviors. Toman also worked with this doctoral student and a post-doctoral associate to assess a construct designed to assess the occupational identity of farmers and examine correlations between farmer identity and adoption of conservation practices.

Berardo worked on a project in collaboration with Tomas Olivier (assistant professor at Florida Atlantic University) and Federico Holm (postdoctoral researcher at the University of Michigan) exploring the governance system that forms when water quality stakeholders participate in the development of non-point source pollution management plans in Ohio. By matching watershed Total Maximum Daily Loading (TMDL) analyses to the content of the management plans, we developed an 'efficacy index' for each plan and use social network analysis (SNA) techniques to examine whether higher levels of efficacy are driven by specific structures in the network of stakeholders participating in the plans.

Berardo also worked on the production of *And Water For all*, a documentary on water affordability in Ohio that is set to premiere on March 22nd, 2022. The movie reviews both the financial challenges to build and maintain the expensive infrastructure to clean both drinking and waste water in rural and urban settings as well as the political difficulties that utilities face when they serve populations that cannot afford to pay for the rapidly increasing rates that they impose.

Hamilton participated in a project integrating assessments of environmental and socio-cognitive processes to construct and derive insight from a systems model of drinking water quality in a region of rural Appalachia that has experienced significant water quality management challenges. Data collection is ongoing and the research team plans to begin dissemination of results during the 2022 summer.

Hamilton also supported research on how farmers, Natural Resource Conservation Service (NRCS) personnel, and agricultural researchers perceive interactions among factors related to soil health. This study, led by two recently-graduated PhD students and published in 2021, revealed significant variation in the cognitive maps of members of these three communities and demonstrated that NRCS personnel and researchers underappreciated the degree to which farmers prioritize soil health in decision-making. Hamilton supported research led by two PhD students on how representatives of local stakeholders collaborate to address climate change adaptation issues (including water resource management) in the Columbus, OH, region. During the 2021 summer, over 100 interviews were conducted; data are currently being analyzed and findings will be disseminated to stakeholders and academic audiences during 2022.

Berardo and Hamilton will continue supporting a PhD student's research on interactions among climate change adaptation issues, organizations, and decision-making processes in Ohio. This research will identify the conditions under which organizations bridge "collaboration gaps" among interrelated climate change adaptation issues, including water quality, nutrient management, and stormwater management. One manuscript was published in 2021, and another is under review.

Jackson-Smith participated in several projects that explore the drivers and constraints of farmer adoption of conservation practices that directly affect water quality outcomes. In 2021, this included analysis of results from a suite of farmer interviews, surveys, and fieldwork (including results of the 2020 Ohio Farm Poll and fieldwork/survey data from a USDA OREI funded project on organic farmer soil health management). He also worked with Wilson (and a team of colleagues from other universities) to develop and publish a conceptual model to integrate insights and lessons from diverse social science theories and literatures.

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

These results benefitted our target audience (farmers, outreach professionals and policy makers) by identifying how best to target and engage unique groups of farmers to promote conservation; how to think about the protection of natural resources in complex governance systems; and how to influence the design and implementation of OSU extension and research programs to accelerate adoption of conservation behaviors. Finally, this project also led to meaningful and sustainable partnerships with and among local communities and organizations.

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

The project improves basic and applied scientific understanding of environmental decision-making, with a focus on interactions among individual behavior, social processes, and institutional structures. A better understanding of the interplay among these elements of environmental management is crucial for designing more effective policies and other interventions that benefit natural and human communities. The general public will benefit from these outcomes over time through improved water governance, improved farmer engagement, increased private lands conservation, and ultimately, improved water quality.

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.

Co Project Directors are Ramiro Berardo, Matthew Hamilton, Douglas Jackson-Smith, Eric Toman - School of Environment and Natural Resources, The Ohio State University

Ten presentations were given to diverse audiences on these findings, including both interdisciplinary academic audiences and members of the public. Fourteen papers were published (with 10 in review or in prep) (see below). Three new grants were submitted and funded that will begin in 2022, one focusing on increasing conservation from 30% to 70% of the acreage in a small watershed to measure the ability to meet water quality goals, one focused on statistically modeling dynamic decisions of farmers in response to information about achieving social and water quality goals at different scales, and the third exploring the social, economic and environmental pros and cons of alternative strategies to integrate crop and livestock

production. A documentary was produced, and several research and policy brief were written. 1 undergraduate, 8 graduate students, and 3 postdoctoral researchers received training on this project. The project also supported 5 faculty with their research appointments.

Journal Articles

Beetstra, M., K. Slagle, and **E. Toman**. 2021. Recognizing dynamic agricultural identities in changing rural landscapes and their impact on conservation practices. Research Note. *Landscape and Urban Planning*. 207.

<https://doi.org/10.1016/j.landurbplan.2020.103999>

Brooker, M.R., J. D'ambrosio, M.M.L. Jones, M. Kalcic, K.W. King, G. Labarge, T. Panchalingam, B.E. Roe, E.R. Schwab, C. Soldo, N.D. Stoltzfus, **R.S. Wilson**, R.J. Winston and J.F. Martin. 2021. "A Public-Private Partnerships to Locate Fields for Implementation and Monitoring of Best Management Practices to Treat Legacy Phosphorus". *Frontiers in Sustainable Food Systems (Waste Management in Agroecosystems)*, 5: 742817.

Epanchin-Niell, R.S., D.B. **Jackson-Smith**, **R.S. Wilson**, M. Ashenfarb, A.A. Dayer, V. Hillis, G.D. Iacona, E.M. Markowitz, S.T. Marquart-Pyatt and T. Treakle. 2021. "Private land conservation decision-making: An integrative social science model." *Journal of Environmental Management*, 302: 113961.

Tellez, C.*, **R.S. Wilson** and H. Walpole. 2021. "Overcoming barriers to government program participation for interested farmers". *Journal of Soil and Water Conservation*, 76(6): 558-567.

Kast, J.*, M. Kalcic, **R.S. Wilson**, D. **Jackson-Smith**, N. Breyfogle, and J. Martin. 2021. "Evaluating the Efficacy of Targeting Options for Conservation Practice Adoption on Watershed-Scale Phosphorus Reductions". *Water Research*, 201: 117375.

Schwab, E.*, M. Kalcic, and **R.S. Wilson**. 2021. "Assessing the accuracy of farmers' nutrient loss risk perceptions". *Environmental Management*, 68(4): 539-552.

Schwab, E.*, **R.S. Wilson** and M. Kalcic. 2021. "Exploring the mechanisms behind farmers' perceptions of nutrient loss risk". *Agriculture and Human Values*, 38(3): 839-850.

Wade, J., M. A. Beetstra, **M. Hamilton**, S. W. Culman, and A. J. Margenot. 2021. "Soil Health Conceptualization Differs across Key Stakeholder Groups in the Midwest." *Journal of Soil and Water Conservation*, 76 (6) 527-533.

Jasny, L, J. Sayles, **M. Hamilton**, L.R. Gomez, D. Jacobs, C. Prell, P. Matous, E. Schiffer, A. M. Guererro, M.L. Barnes. 2021. "Participant Engagement in Environmentally Focused Social Network Research." *Social Networks* 66: 125-38. <https://doi.org/10.1016/j.socnet.2021.01.005>.

Hamilton, M., A.P. Fischer, L. Jasny. 2021. "Bridging Collaboration Gaps in Fragmented Environmental Governance Systems." *Environmental Science & Policy* 124: 461-70.

Olivier, T., and **R. Berardo**. 2021. "Birds of a feather fight together: forum involvement in a weakly institutionalized ecology of policy games." *Policy Studies Journal*. DOI: 10.1111/psj.12418.

Sprunger, C., S. Culman, L. Deiss, C. Brock, and D. **Jackson-Smith**. 2021. Which management practices influence soil health in Midwest organic corn systems? *Agronomy Journal* 113:4201-4219. <https://doi.org/10.1002/agj2.20786>.

Culman, S., C. Brock, D. Doohan, D. **Jackson-Smith**, C. Herms, V.N. Chaganti, M. Kleinhenz, C.D. Sprunger, and J. Spargo. 2021. Base cation saturation ratios vs. sufficiency level of nutrients: a false dichotomy in practice. *Agronomy Journal* <https://doi.org/10.1002/agj2.20787>

Brock, C.*, D. **Jackson-Smith**, S. Culman, C. Herms and D. Doohan. 2021. Organic corn production practices and profitability in the eastern Corn Belt. *Sustainability* 13:8682. <https://doi.org/10.3390/su13168682>

Presentations

R.S. Wilson, A. Wilson and M. Doidge. 2021. "Ohio State studies the climate and agriculture". Invited speaker on the 'Our Ohio Weekly' [Podcast](#). Virtual Event.

R.S. Wilson, H. Walpole and C. Tellez. 2021. "Farmer climate adaptation: Farming harder, farming different and stopping altogether". Speaker at the Soil and Water Conservation Society Annual Conference. Virtual Event.

R.S. Wilson. 2021. "Understanding climate adaptation decisions in large-scale agriculture". Invited seminar speaker at the Stanford University Series "Approaching sustainability: Conversations with leading scholars". Virtual Event.

R.S. Wilson. 2021. "Land-use behavior and keeping the ecological carbon isolated". Invited panelist at The Ohio State University Sustainability Institute Energy Symposium "What does it mean to go negative?". Virtual Event.

R.S. Wilson and A. Wilson. 2021. "Agroecosystem resilience: Regional integrated modeling of farmer adaptations to guide management in a changing climate". Invited speaker at the NC3 Webinar Series. Virtual Event.

R.S. Wilson. 2021. "Understanding climate adaptation and mitigation decisions in large-scale agriculture". Invited speaker at The Ohio State University Department of Marketing Brownbag. Virtual Event.

R.S. Wilson and M. Doidge. 2021. "Understanding climate adaptation decisions in the eastern Corn Belt". Invited speaker at Environmental Science Graduate Program Seminar. Virtual Event.

M. Hamilton, C. Evers, M. Nielsen-Pincus. 2021. "Cross-jurisdiction coordination of risk in fragmented governance settings". Annual Meeting of the American Association of Geographers (virtual presentation).

R. Berardo. 2021. "Uncovering the polycentric nature of water quality governance: Evidence from Ohio's Nonpoint Source Implementation Strategic Plans." Invited speaker at the Department of Political Science, Purdue University. April 27.

D. Jackson-Smith "Hypoxia Task Force States Nutrient Reduction Strategies," Panel organizer and presenter at 2021 University Consortium for Water Research (UCOWR) annual meeting (virtual), June, 2021. (Co-authored with A. Wilke, C. Wardropper, K. Genskow, and A. Rissman).

Other Products

R. Berardo. "And Water For All: A documentary on water affordability in Ohio." The documentary will be released on March 22nd, 2022 (World Water Day). Pre-production started in April of 2021, production took place from late July to early December.

Beestra, M. Policy Brief 1. Farmer Resources and Cover Crop Perceptions Fluctuate Throughout the Year. CFAES.

Beestra, M. Policy Brief 2. Fluctuating Resources and Cognition Lead to Seasonal Scarcity Among Farmers. CFAES.

Beestra, M. Policy Brief 3. Farmer Perceptions of the COVID-19 Pandemic and Implications for Conservation. CFAES.

Beestra, M. Policy Brief 4. Suggested Changes to Current Cover Crop Incentive Programs. CFAES.

Beestra, M. Policy Brief 5. Farmers Perceive Cover Crop Benefits and Challenges as Fluctuating Throughout the Year. CFAES.

Beestra, M. 2021. Increasing Adoption of Cover Crops and Other Conservation Tools Among Ohio Farmers. OSU Knowledge Exchange Research Brief. kx-assets.s3.amazonaws.com/2021-03/KX_PolicyBriefs_v4.pdf

Watershed modeling to enhance water quality and agricultural production

Project Director

Jay Martin

Organization

Ohio State University

Accession Number

1014686



Result 1

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

This project address to two important gaps in knowledge to balance agricultural production and water quality: 1. it is unknown how long effective BMPs require, and what annual rates of adoption are needed to reach mandated water quality targets, and 2. it is unknown how changes in climate will impact the ability of BMPs to reach these targets.

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

In a continued stakeholder-driven, multiple-modeling collaboration, we identified feasible scenarios that would likely be adopted across agricultural lands that comprise ~80% of the watershed. We then analyzed scenarios with future climate inputs to understand how discharge and management needs may change with variations in precipitation and temperature. This is described in several peer-reviewed papers (Kujawa et al., 2021; Evenson et al., 2021; Martin et al., 2021).

We have also expanded on this project along two themes.

First, we are monitoring and modeling soil health and the corresponding impact on water quality. We are monitoring properties related to soil health on fields in Ohio and determine whether there are relationships between soil health and water quality in agricultural runoff. We are also focusing on critical hydrology model improvements needed to more accurately simulate soil health improvements, including soil physical properties, in the Soil and Water Assessment Tool (SWAT), a watershed model used to simulate the effects of BMPs on water quality.

Second, we are monitoring and modeling legacy phosphorus in agricultural fields. We are expanding our stakeholder-driven approach to engage with nutrient service providers (NSPs), such as agronomists and certified crop advisors who provide technical assistance to producers in fertilizer management at a field scale. This public-private partnership will be used to implement BMPs on farm fields with elevated phosphorus levels, and we will assess the outcomes with edge-of-field monitoring and simulate extrapolation of the approach with the SWAT model.

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

Our research group has presented findings to the broader research community through the professional conferences, as well as through stakeholder meetings and targeted working groups. We have also presented findings to local and regional stakeholders through invited presentations to Ohio Environmental Protection Agency, Ohio Department of Agriculture, targeted meetings through Ohio State University's College of Food, Agricultural, and Environmental Sciences, and through workshops with a stakeholder advisory group composed of experts and advocates in agricultural, environmental, and policy sectors.

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

Through work with the agricultural and scientific community we have identified management plans with the potential to achieve water quality goals for Lake Erie while maintaining agricultural productivity. Broader public benefits of this achievement include; food supply, water quality improvements, and improved recreational and cultural benefits from surface waters.

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.

Co-Project Directors:

- Margaret Kalcic - Food, Agricultural and Biological Engineering, The Ohio State University

- Ryan Winston - Food, Agricultural and Biological Engineering, The Ohio State University

Publications:

Brooker, M.; D'Ambrosio, J.; Jones, M.; Kalcic, M.; King, K.; LaBarge, G.; Panchalingham, T.; Roe, B.; Schwab†, E.; Soldo, C.; Stoltzfus, N.; Wilson, R.; Winston, R.; Martin, J. (2021). A public-private partnership to locate fields for implementation and monitoring of best management practices to treat legacy phosphorus. *Frontiers in Sustainable Food Systems*. doi: 10.3389/fsufs.2021.742817.

Schwab†, E.; Kalcic, M.; Wilson, R. (2021). Assessing the accuracy of farmers' nutrient loss risk perceptions. *Environmental Management*, 68, 539–552. doi:10.1007/s00267-021-01519-1.

Kast, J.; Kalcic, M.; Wilson, R.; Jackson-Smith, D.; Breyfogle, N.; Martin, J. (2021). Evaluating the Efficacy of Targeting Options for Conservation Practice Adoption on Watershed-Scale Phosphorus Reductions. *Water Research*, 201, 117375. doi:10.1016/j.watres.2021.117375.

Schwab†, E.; Wilson, R.; Kalcic, M. (2021). Exploring the mechanisms behind farmers' perceptions of nutrient loss risk. *Agriculture and Human Values*, 38, 839–850. doi:10.1007/s10460-021-10196-z.

Martin, J.; Kalcic, M.; Aloysius, N.; Apostel†, A.; Brooker, M.; Evenson†‡, G.; Kast, J.; Kujawa†, H.; Murumkar‡, A.; Becker, R.; Boles, C.; Confesor, R.; Dagnew, A.; Guo, T.; Long, C.; Muenich, R.; Scavia, D.; Redder, T.; Robertson, D.; Wang, Y. (2021). Evaluating management options to reduce Lake Erie algal blooms using an ensemble of watershed models. *Journal of Environmental Management*, 280, 111710. doi: 10.1016/j.jenvman.2020.111710.

Evenson†‡, G.; Kalcic, M.; Wang, Y.; Robertson, D.; Scavia, D.; Martin, J.; Apostel†, A.; Aloysius, N.; Kast, J.; Kujawa†, H.; Boles, C.; Redder, T.; Confesor, C.; Guo, T.; Muenich, R.; Dagnew, A.; Murumkar‡, A.; Brooker, M. (2021). Uncertainty in critical source area predictions from watershed-scale hydrologic models. *Journal of Environmental Management*, 279, 111506. doi:10.1016/j.jenvman.2020.111506. [Conception 50%; Interpretation 40%; Data Collection 30%; Writing 30%]

Apostel†, A.; Kalcic, M.; Dagnew, A.; Evenson†‡, G.; Kast, J.; King, K.; Martin, J.; Muenich, R.L.; Scavia, D. (2021). Simulating internal watershed processes using multiple SWAT models. *Science of the Total Environment*, 759, 143920. doi:10.1016/j.scitotenv.2020.143920.

Scavia, D.; Wang, Y.C.; Obenour, D.R.; Apostel†, A.; Basile, S.J.; Kalcic, M.; Kirchoff, C.J.; Miralha, L.; Muenich, R.L.; Steiner, A.L. (2021). Quantifying uncertainty cascading from climate, watershed, and lake models in harmful algal bloom predictions. *Science of the Total Environment*, 759, 143487. doi:10.1016/j.scitotenv.2020.143487.

Miralha, L.; Muenich, R.L.; Scavia, D.; Wells, K.; Steiner, A.L.; Kalcic, M.; Apostel†, A.; Basile, S.; Kirchoff, C.J. (2021). Bias correction of climate model outputs influences watershed model nutrient load predictions. *Science of the Total Environment*, 759, 143039. doi:10.1016/j.scitotenv.2020.143039.

Shedekar‡, V.; King, K.; Fausey, N.R.; Islam, R.R.; Soboyejo, A.B.O.; Kalcic, M.; Brown, L.C. (2021). Exploring the effectiveness of drainage water management on water budgets and nitrate loss using three evaluation approaches. *Agricultural Water Management*, 243, 106501. doi:10.1016/j.agwat.2020.106501.

Kast, J.; Apostel†, A.; Kalcic, M.; Muenich, R.; Dagnew, A.; Long, C.; Evenson†‡, G.; Martin, J. (2021). Source contribution to phosphorus loads from the Maumee River watershed to Lake Erie. *Journal of Environmental Management*, 279, 111803. doi:10.1016/j.jenvman.2020.111803.

Simpson, I.M., Winston, R.J., and Tirpak, R.A. (2021). "Assessing maintenance techniques and in-situ pavement conditions to restore hydraulic function of permeable interlocking concrete pavements." *Journal of Environmental Management*. 294, 112990.

Tirpak, R.A., Winston, R.J., Feliciano, M., Dorsey, J.D., and Epps, T.H. (2021). "Impacts of permeable interlocking concrete pavement on the runoff hydrograph: Volume reduction, peak flow mitigation, and extension of lag times." *Hydrological Processes*. 35:e14167.

Tirpak, R.A., Afrooz, N. ARM, Winston, R.J., Valenca, R., Schiff, K., and Mohanty, S. (2021). "Designing bioretention soil media for stormwater quality improvement: A critical review of research progress, challenges, and opportunities." *Water Research*. 189, 116648.

Baird, J., Winston, R.J., and Hunt, W.F. (2021). "Evaluating the Hydrologic and Water Quality Performance of Novel Infiltrating Wet Ponds." *Blue-Green Systems*. 2(1).

Luell, S.K., Winston, R.J., and Hunt, W.F. (2021). "Monitoring the water quality benefits of a triangular swale treating highway runoff." *Journal of Sustainable Water in the Built Environment*. 7(1), 05020004.



Sustainable bioplastics for food packaging

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

Bacterially synthesized poly-(3-hydroxybutyrate-hydroxyvalerate) PHBV, although a promising compostable bio-plastic and potential plastic packaging replacement polymer, has limited use due to thermal degradation, and brittleness at room temperature. Blending of PHBV with natural rubber (NR), when optimized, can improve both the impact resistance and toughness properties of the material. Various unique requirements need to be met when considering a material for food packaging applications that encompass the dynamic interaction between food, packaging material and the environment. Additionally, other more common properties such as gas and water vapor permeability, mechanical changes, sealing and thermoforming capabilities, machinability, transparency, anti-fogging, printability, resistance to light, water, acid, grease, availability and of course cost all are important factors.

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

This year, our multidisciplinary team has concentrated on scaling up our polymer blend in an industrial setting. To that end we have worked closely with Mucell and Plastilene, two packaging companies, to produce the materials in a pilot scale with results that can be directly translated to large industrial setting. The PHBV/NR blend sent to Plastilene did not successfully sheet in the pilot equipment. However, when 0.5-1.0% epoxidized spent coffee ground oil was added, results were dramatically improved. Various batches were tested and sheeting was very successful. To scale up to the next level of manufacturing, The blend has been sent to the Mucell facility. Funds are being sought to produce prototype food trays and cosmetic tubes from the blend to help in commercializing this technology. Additionally, various material characterization tests are being conducted on the Plastilene products to assure the material will meet industry expectations. These include thermal and rheological analysis, water and gas permeability tests and biodegradability tests.

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

This reporting term we have worked on translating our laboratory results of a promising biobased, compostable food packaging material to an industrial setting. Working with partner companies we have shown that our blend can be processed as prototypes by industry. When project is complete, we hope to have viable, well characterized more sustainable food packaging alternatives. These packaging alternatives, if utilized by industry would greatly decrease the landfill burden

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

Utilizing more sustainable, compostable food packaging can decrease waste as well as lower the environmental impact of traditional plastics.

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.

Concerns over environmental pollution have stimulated research in biobased biodegradable plastic materials. Current estimates predict that the food packaging market will grow from USD \$292.91 billion in 2018 to USD \$378.58 billion in 2022. This expected increase is due to consumer demands for food product packaging that offers convenience, the rising urban population, and to minimize food waste. Plastic packaging accounts for >30% of global plastic consumption, with >99% of them being derived from fossil-derived carbon and highly recalcitrant in the environment. Moreover, plastic packaging is commonly (>50%) single use prior to disposal.

Thus far, recycling has failed to provide solutions to mitigate the accumulation of these plastics in landfills. Aside from the plastic recycling rate being low (<10%), what is recycled has diminished value since most of these materials are downcycled such they are disposed into landfills. The packaging industry is actively seeking alternative materials that meet or exceed cost-performance requirements of current plastics while being biodegradable in defined conditions and, based on lifecycle analysis, have favorable reductions in greenhouse gas emissions and energy utilization.

Dr. Yael Vodovotz's and Dr. Katrina Cornish's research on a PHBV/NR blend can potentially help advance the field of bioplastic food packaging and represent progress toward our larger goal of developing state-of-the art bio-based and/or biodegradable food packaging materials to improve the sustainability of the food industry by reducing plastic waste.

Critical Issue

OSU - Food Security and Production

[Connecting Science to Farm Fields: The Ohio State Digital Agriculture eFields Program](#)

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7002750



Connecting Science to Farm Fields: The Ohio State Digital Ag eFields Program 2021 Results

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

OSU Extension, in partnership with faculty in the Department of Food, Agricultural, and Biological Engineering and Ohio State's College of Engineering, conducts research and educates producers about best practices that increase yield and profitability. In 2017, the Digital Agriculture team decided to initiate a new on-farm research effort that was named eFields. The twenty-person team included county educators, field specialists, students and on-campus faculty. eFields is an Ohio State program dedicated to advancing production agriculture using field-scale research. This program utilizes modern technologies and information to conduct on-farm studies with an educational and demonstration component used to help farmers and their advisors understand how new practices and techniques can improve farm efficiency and profitability. The program is also dedicated to delivering timely and relevant, data-driven, actionable information.

As the Digital Ag Team reflected on 2021 in this year's eFields editorial message, the COVID-19 pandemic continued to impact the agriculture industry and beyond. As the year progressed, supply chain and labor issues created unique challenges. Shortages in parts and electronic components made making repairs difficult by harvest time. Some crop protection products were difficult to buy in late summer. Unfortunately, supply shortages, labor, and now energy costs have impacted the supply and costs of inputs. Fertilizer prices are at an all-time high as 2021 comes to end with it being difficult to purchase crop protection products. Fortunately for Ohio farmers, the 2021 growing season was favorable, leading to high yields that have helped offset input price increases.

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 its first year (2017), a total of 45 studies were conducted in 14 counties with 39 partnering farms that also included 21 industry partners, which supported various projects. The eFields project has continued to expand since 2017. In 2021, the eFields project included: 249 studies, 144 farm collaborators, 78 industry partners, and 68 Ohio State investigators. Projects covered seven focus areas: precision seeding, precision nutrient management, precision crop management, soil compaction, remote sensing, forages and data analysis and management. Results from all five years are provided to stakeholders as a printed report and also as an online publication available at go.osu.edu/eFieldsReports. The annual report highlights how technology and input management decisions can improve Ohio crop production. Distribution and viewing included more than 40 US states and 38 additional international countries.

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

The eFields program has expanded on-farm research across the state and strengthened relationships between farm managers and Extension professionals. Key results (in 2020) included the soybean seeding rate studies, fertilizer management, and soil health studies. The soybean seeding rate results indicated farmers could plant less seed while maintaining yield with an optimum soybean seeding rate between 120,000 and 140,000 seeds/ac. Fertilizer results highlight the importance of application placement and timing. A soil health survey of 88 farm fields in Ohio has helped provide data for Ohio farmers to begin benchmarking soil health metrics and understanding how management practices impact soil health. Feedback from farmers and consultants has been excellent with suggestions on how to improve future programs and what studies farmers would like to see completed by Ohio State.

Current projects are focused on precision nutrient management strategies and technologies to improve efficiency of fertilizer placement, enable on-farm evaluation, automate machine functionality, enhance placement of pesticides and seed, and to develop analytical tools for digital agriculture.

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

The 2021 eFields Report (go.osu.edu/eFieldsReports) is a culmination of the research conducted during the past year on partner farms throughout Ohio. With our **new interactive** eFields map (<http://go.osu.edu/KXeFieldsMap>), which was developed in partnership with the college's Knowledge Exchange unit, stakeholders can easily find relevant reports in the eFields research from the past five years.

Mitigating Food Insecurity with Community Service and Food Production Education Programs

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7002749



Mitigating Food Insecurity with Community Service and Food Production Education Programs – 2021 Results

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

Food insecure populations often must carefully manage limited resources when dietary choices are made, often impacting the quality of foods consumed. Consumption patterns low in fruits, vegetables, low-fat dairy, and whole grains and high in less expensive starchy foods contribute to risks for obesity and diet-related chronic diseases. Chronic diseases, such as diabetes, compound food insecurity since they are costly to manage and therefore compete with limited financial resources. Furthermore, acquiring healthy foods and managing food dollars might be especially challenging in impoverished rural communities lacking full-service grocery stores, markets, or services. Community organizations, food pantries, and food insecure families do not always engage with one another to address challenges. Consequently, opportunities are missed to fully capitalize on local human, natural, and financial resources to effectively address community food insecurity.

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 major community service-type projects, "Urban October" and Master Gardener Volunteer donations, helped to mitigate food insecurity by providing shelf-stable meals and fresh produce to food insecure communities.

Tim McDermott, Agriculture and Natural Resource Extension Educator in Franklin County developed an online course to teach individuals how to grow their own food year-round. He reports that new gardeners, educators, and students continue to be engaged by this programming. In 2021, he was able to return to both in-person and virtual classes and in many cases the same program is supported both ways to maximize engagement.

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

In 2021, OSU Extension partnered with the Office of Student Life to build awareness about the majors within our college but particularly, the work of Extension and recruitment for future Extension professionals. Recent collaborations with the Office of Student Life included a service project to celebrate Urban October, where 500 volunteers packed 188,000 shelf-stable meals and OSU Extension and hundreds of local organizations distributed those meals at five locations in the Mahoning Valley area to food insecure individuals.

During 2021, our 3,250 master gardener volunteers have recruited more than 700 interns, completed nearly 50,000 hours of continuing education, and volunteered more than 100,000 volunteer hours, responding to nearly 10,000 gardener and homeowner Ask the Expert questions, and donated more than 85,000 pounds of fresh produce to food insecure individuals and local food banks.

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

Nearly 4,000 volunteers across Ohio (both master gardeners and food packers) came together to help address the food insecurity issues in Ohio. Tim McDermott's year-round gardening program was offered virtually not only to Franklin County client-residents, but also to the Ohio State community. The *Growing Franklin* website/blog, which is accessible to all, was a critical piece of digital infrastructure used to house created content for easy sharing and secondary viewing.

Identification and molecular evolution of genes underlying adaptive traits in wild *Vitis* species.

Project Director

Andrea Gschwend

Organization

Ohio State University

Accession Number

1021403



Transcriptomic investigation of genes that underlying adaptive traits in *Vitis labrusca*.

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

With increased erratic weather events and land use efficiency issues, we need crops that are resilient to diverse environmental stress. Grapes are the highest valued fruit crop in the United States but breeding cultivated grapevines for increased yield and quality traits, followed by clonal propagation, has decreased their genetic diversity, making them more susceptible to weather and pathogen pressures. Crop wild relatives, on the other hand, have gone through natural selection to survive in their changing environments. By using comparative and functional genomic techniques, my lab identifies genetic variation that provides grapevines and their wild relatives with resilience to abiotic and biotic stress, for integration of these genes into cultivated varieties.

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.

Grape production in the United States was valued at 4.78 billion dollars in 2020. The species of grape commonly used for wine production is *Vitis vinifera*, and has distinct varieties, such as Chardonnay, Pinot Noir, and Cabernet Sauvignon. *V. vinifera* is not well adapted to the diverse climates and pests found in the United States, limiting its growing range; in areas where grown, it requires large amounts of fungicides and pesticides, at great costs to growers. North America has many native wild grapevine species that grow across the country and are adapted to their local climates and pests. These wild North American grapevines have been used to make hybrid cultivars with *V. vinifera* to create cold tolerant or pest resistant varieties, but breeders have yet to fully exploit the extensive genetic diversity available in wild grapevine species, as many of the underlying genes contributing to these adaptive traits have yet to be identified.

Since the initiation of this study, we have sequenced, assembled, and analyzed the first long-read, haploid-resolved *Vitis labrusca* genome, a wild grapevine species that grows in the Northeastern United States. This grapevine species is tolerant to cold temperatures and many local pathogens and has some unique berry traits compared to *V. vinifera*. We performed comparative genomic analyses with *V. vinifera* varieties, as well as another wild grapevine (*V. riparia*), to explore genomic structural differences between wild and cultivated grapevine and identified genetic variation that may underlie adaptive traits. A manuscript over our findings is under revision to be re-submitted to The Plant Journal. These research efforts accomplish Objectives 1a, 1b, and partially accomplish 1c as described in the Project Methodology.

For the 2021 reporting period, we have made significant progress towards Objectives 1c and 2a. We have generated an extensive *V. labrusca* transcriptome dataset encompassing 14 different tissue types and three developmental stages, making it one of the most comprehensive transcriptome data sets for grapevine. We are currently carrying out comparative analyses between wild and cultivated grapevine transcriptomes. We have selected abiotic (cold damage) and biotic (insect herbivory) threats to grapevine yield to further pursue to identify the genes involved in resilience in *V. labrusca* compared to *V. vinifera*. We have carried out a set of bud dormancy and deacclimation studies to identify genes involved in this important process. We also performed insect herbivory studies to identify genes involved in *V. labrusca* insect herbivory resilience compared to *V. vinifera* susceptibility. We will use our transcriptome findings to identify genes that provide resistance to pathogens and tolerance to extreme weather conditions, to inform breeding and gene editing efforts to improve our grapevine varieties. Our progress for 2021 is described in more detail below.

Objective 1. Investigate the evolution of adaptive traits in the *Vitis* genera

Ribosomal protein evolution in grapevine

We investigated the gene families that encode ribosomal proteins, which make the complexes essential for translation and protein production. Ribosomal protein genes are conserved and dosage-sensitive, but we found that the ribosomal protein gene families in *Vitis* have undergone gene gain and loss events, but interestingly, the overall gene expression for each gene family was similar. Our findings highlight different methods of gene dosage balance in ribosomal gene families and provide insight into gene family evolution in grapevine. A manuscript detailing our results is in the final stages of preparation.

Objective 2. Study the transcriptome response to abiotic and biotic stress resistance in wild and cultivated *Vitis* species.

V. labrusca reference transcriptome

Besides berries and leaves, there are few other grapevine tissues with transcriptomic sequences available, especially for wild grapevine species. We generated an extensive *V. labrusca* transcriptome dataset encompassing 14 different tissue types (Leaves, buds (3 stages of development), stems, roots, tendrils, shoot tip, berries (3 stages of development), and inflorescences (3 stages of development), making it one of the most comprehensive transcriptome data sets for grapevine. We are currently carrying out gene expression analyses across tissue types, between developmental stages, and between wild and cultivated grapevine tissues. We aim to identify genes that contribute to unique traits in *V. labrusca*, which can be used for future breeding efforts.

Herbivory resilience in wild grapevine

Insect herbivory can be a major source of yield loss in grapevine. In general, cultivated *V. vinifera* varieties are much more susceptible to insect herbivory than wild grapevine species. We investigated this further by carrying out an insect herbivory study using a leading grapevine insect pest, *Popillia japonica* (Japanese Beetle). We carried out a series of choice assays, where we allowed the beetles to feed on either a *V. labrusca* and *V. vinifera* leaf and quantified the leaf area consumed. The beetles ate eight times more of the *V. vinifera* leaves than the *V. labrusca* leaves. We next wanted to determine the defense mechanisms present in *V. labrusca* that were deterred feeding. We investigated mechanical defenses, such as trichomes, and found trichome density to be significantly greater on *V. labrusca* leaves. We also are investigating the production of chemical defense compounds. We allowed the beetles to feed on the *V. vinifera* and *V. labrusca* leaves for 0 hours, 0.5 hours, 1 hour, and 4 hours and collected these leaves for RNA sequencing. We recently received the transcriptome sequences data back and are in the process of analyzing it. We will also carry out metabolomics to identify the chemical compounds being produced.

Cold stress response in V. labrusca

With weather events becoming more erratic, a spring frost, occurring after the buds have already broken dormancy, can damage the tender grapevine bud tissue and be detrimental to grape yield for the following season. My lab is investigating the genes that underlie grapevine bud dormancy and cold deacclimation in wild and cultivated grapevines, which vary in their cold hardiness, required chilling hours, and cold deacclimation timeline. We are investigating the number of chilling hours necessary to break dormancy for plants collected from different *Vitis labrusca* populations. We are specifically interested in differences between *V. labrusca* populations and the genetic variation that might underlie these differences. We have collected two years of chilling requirement data and preliminary data suggests a significant decrease in days to bud break, as chilling hours increase, with an average of 15 days after 548 hours and 6 days after 1220 hours of chilling. There is also variation in chilling requirement across accessions. We performed Quantitative PCR to investigate the

expression of cold hardy genes in *V. labrusca* and discovered different CBF gene copies are expressed under 4°C, -10°C, and -20°C cold treatment conditions. Moving forward, we plan to carry out transcriptomics studies to get a comprehensive picture of genes involved in deacclimation and spring freeze response in wild *V. labrusca* compared to *V. vinifera*.

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

The target audiences reached by my efforts on this project include collaborators, breeders, and the scientific public.

Grapevine collaborators from OSU and other universities have benefited from the results of this project, by using our findings as preliminary data for collaborative grants. We have also uploaded our *V. labrusca* genome sequence and gene annotations to NCBI, so it can be accessed and utilized by other grapevine scientists or grapevine breeders and used for further studies or molecular breeding initiatives. *V. labrusca* is a popular parent species of cultivated hybrid varieties, so breeding programs and companies can use our results to target genes of interest for introgression. Also, our findings on grapevine genome evolution advances our basic biological understanding of how plant genomes evolve and more clearly elucidates the origin and retention of genetic variation that provides an adaptive advantage.

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

The public will benefit from the project accomplishments through the use of our genetic findings by breeders and companies to produce varieties that maintain fruit quality traits, but increase abiotic and biotic stress resilience. For grapevine growers, use of these varieties that are resilient to biotic pathogens will decrease the need for pesticide, fungicide, and other costly treatments on their vines. Resilience to abiotic stress may also allow for different grapevine varieties to be grown outside of their current growth zone, providing growers with more grapevine varieties, which could have positive economic impacts. The wine industry is very lucrative with local vineyards and wineries becoming increasingly popular tourist destinations. In Ohio, for example, the grape and wine industry has a 1.3 billion dollar impact on the state's economy annually (findohiowines.com). Consumers will benefit from the greater varieties of grapes grown regionally, which will increase the diversity of wines and table grapes that are locally produced and sold. Increase in sales of local wine would in turn benefit each state's economy and the people who live there.

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

Changes in your project or problems encountered

Overall, the project is progressing as planned, but we have experienced a few minor setbacks. Since grapevines are perennials, we were still struggling with some plant health issues stemming from the Covid-19 quarantine in 2020. We were able to request new cuttings from the USDA and propagate some new plants, as well as design a treatment regime for our remaining grapevine plants. In addition, we had issues isolating high quality RNA from our grapevine tissues. Many kits and protocols are made for animal, bacterial, or model plants, like *Arabidopsis*. The RNA isolation kits did not work for grapevine RNA isolation. We needed to repeat many of the RNA isolations for our *V. labrusca* tissues and create our own protocol, which took extra time to collect additional tissue and isolate high quality RNA for sequencing. In addition, my lab lost a postdoc and a graduate student, which also significantly slowed our progress on our project aims.

Opportunities for training and professional development

This project has many opportunities for training. My team of three graduate students and a postdoc received hands on training through experiments in the laboratory, computational and bioinformatics analyses, and manuscript writing, while tackling the objectives of this project. My postdoc is an expert in bioinformatics and computational genetics. He worked with my graduate students to train them on how to assemble and analyze transcriptome data and how to annotate a genome. My graduate students have also trained each other on lab techniques, for example more experienced graduate students have trained the less experienced graduate students on our grapevine RNA isolation protocol. All three graduate students also attend bioinformatics workshops to strengthen their data analysis skills. They have also presented their research at local and a national conference to gain additional experience in science communication and have won awards for their research talks and posters.

My postdoc also had a chance to enhance his skills and professional development, mostly through independent study and collaboration with me and our colleagues. He has presented his findings at multiple local research symposia and won awards for his posters. He and I have also worked closely on this project and manuscript writing, so he is further developing

professional skills from this interaction. He recently accepted a permanent position as a research scientist at OSU, but the training he received in my lab benefited his career.

Four undergraduate students also gained practical research experiences in the lab. They had the opportunity to learn lab skills and experimental techniques, such as PCR, RNA isolation, and Q-PCR, from myself and my graduate students. They have presented posters over their results (related to this project) at departmental and university research symposia. One of my undergraduate students will be graduating with research distinction this May.

How results were disseminated to target audiences or communities of interest

My team has presented our project results at multiple research symposia, seminars, and outreach events. My postdoc presented his results as a poster and gave an oral presentation at the HCS graduate student research symposium. He also presented a poster at the 14th annual international scholar research exposition, the OSU Plant Sciences Symposium, and at the 2021 CFAES Annual Research Conference, where he won third place for his poster.

My graduate students have presented their project proposals to our department at the HCS graduate student research symposium and via the departmental seminar series. They have also presented posters at the 2022 Plant and Animal Genome conference (PAG). My graduate students have also participated in community outreach events with me and post research blogs.

In addition to community outreach, I have presented our project findings at five different local and state seminars. I have made our sequencing data available on NCBI, so the scientific community can access it. The most effective and far-reaching dissemination of our results will be in the form of a peer-reviewed journal article, which we are in the final stages of editing and re-submitting.

Plans for next year's activities

Next year we will be carrying out analyses on our transcriptome data. We will analyze our *V. labrusca* transcriptome data for the 14 tissues, carry out comparative analyses with *V. vinifera*, and look at genes involved in bud, flower, and berry development. We will also analyze our herbivory transcriptome dataset and identify genes that are involved in herbivory defense in *V. labrusca* and *V. vinifera*. We will identify any unique genes between the two that provide increased resilience in *V. labrusca*. We will also carry out an experiment related to frost response in wild and cultivated grapevines and investigate genes involved in frost tolerance.

In addition, my team will continue to prepare and submit manuscripts over the completed aspects of the project and present our findings at local and national conferences. I am also planning to bring in another graduate student and undergraduate student to mentor and who will contribute to addressing the remaining project objectives.

Publications resulting from or related to the project

Li, B.; Gschwend, A.R. *. (2022). Intragenomic Variation and Segmental Duplication Drive Genome Diversification of Wild and Cultivated Grapevines. Submitted to: Under revision for re-submission to The Plant Journal.

Li, B.; Gschwend, A.R.*. Ribosomal RNA protein gene divergence in grapevine and implications for heterogeneous ribosomes. Manuscript 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.

Grapes are the highest valued fruit crop in the United States and the wine grape industry has a billion-dollar impact in Ohio's economy. Many cultivated grapevine varieties are not well-adapted to the various climates and pests found throughout the United States, limiting their growing regions and requiring extensive management programs with a great cost to growers. As the number of vineyards and wineries continues to increase across the United States, there is growing demand for more resilient wine grape (*Vitis vinifera*) cultivars.

Wild grapevine species grow across the country and are adapted to their local environments. Hybrid cultivars have been generated to combine the adaptive traits of wild grapevine species with the fruit quality traits of *V. vinifera* varieties, yet the genes that underlie these adaptive traits in wild grapevines are still largely unknown.

Dr. Andrea Gschwend's lab used a comparative approach to make significant strides in identifying the genes that underlie important adaptive traits in wild grapevines and understanding how those genes evolved. They were able to identify genes in wild grapevines that are predicted to increase cold tolerance and fungal and pest resistance. The ultimate goal of this research is to use these genes as targets for molecular breeding or genetic engineering to incorporate them into *V. vinifera* grapevine cultivars, making the cultivated grapevines more resilient to a broader range of environmental stress, increasing yield without losing important fruit quality traits. These new varieties will have broader growing regions, contributing to the economic impacts of the grape industry in these impacted states, and will require less input of pesticides and fungicides, making these new varieties more cost effective and environmentally sustainable.

HANDHELD SURFACE-ENHANCED RAMAN SCATTERING (SERS) SENSORS FOR FIELD MONITORING OF CHEMICAL CONTAMINANTS

Project Director

Luis Rodriguez-Saona

Organization

Ohio State University

Accession Number

1021117



Non-Destructive Raman Technique for Aflatoxin Screening

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

Having a rapid technological approach to making the assessment of aflatoxin in high-risk crops would result in both assurance of regulatory compliance as well as cost savings in the production of products. Aflatoxins are fungal bio-agents that merit attention on account of being highly toxic and carcinogenic to humans and great threat to vulnerable agricultural commodities. Many methods for assessing fungal-contaminated crops have been developed, because of regulatory restrictions. However, the laborious, slow, complex and expensive sample preparation and analytical methods (thin-layer chromatography, high-pressure liquid chromatography, immunoaffinity columns, and enzyme-linked immunosorbent assays) limit non-destructive real-time assessments. A real time sensitive approach to continually monitor this process could result in a significant cost savings to the industry.

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 survey of 1000 peanuts showed low prevalence of aflatoxin with only 27 peanuts containing 20 ppb or higher aflatoxin levels. However, 18 peanuts showed levels ranging from 1.8 ppm to 1%. Raman spectroscopy is positioning as an attractive fingerprinting technique for screening for contaminants. Advantages of Raman spectroscopy include portable and ruggedized instrumentation for field deployment, little or no sample preparation requirement, non-contact and non-destructive capabilities. We have employed a new generation of handheld Raman spectrometers that are equipped with a near-infrared excitation wavelength (1064nm) and InGaAs array detector that eliminates the fluorescence limitation and improves the Raman signal intensity. Our results show the feasibility of using this non-destructive Raman technique for detection of aflatoxin contamination in the surface of peanuts. We have developed the calibration with 60 peanuts that were inoculated with levels of aflatoxin ranging from 0.35 to 5 ppm. This non-destructive approach has allowed discriminating peanuts tainted with aflatoxin from controls with no miss-classification when using a validation set. We have adapted a method capable of simultaneously acquiring quantitative information of aflatoxin levels by using QuEChERS to eliminate matrix interference and allowing quantifying aflatoxin levels from single peanuts. LC-MS/MS allowed to determine levels of aflatoxin on single peanut that were spiked with the mycotoxins for development of classification model based on Raman spectroscopy. The method showed excellent agreement with levels inoculated in peanuts for development of the calibration models. This new capability has confirmed the accuracy of the spiking method for developing an external set of standards and was used for generating a PLSR model for prediction based on Raman spectra. However, considering aflatoxin hazard to health, many countries have established mandatory regulations of aflatoxin level in food and agricultural products. The Food and Drug Administration (FDA) in the United States has set the limiting value of aflatoxin content at 20 ppb for food and 300 ppb for feed. Since our initial study employed the lowest level of 350 ppb, we explored the sensitivity of the Raman technology by chemically spiking peanuts at levels ranging from 20 to 400 ppb. Spectra was collected on two sides for each peanut, one of the sides was spiked with aflatoxin and the opposite side of the peanut served as control. Raman spectra showed unique spectral patterns of the peanut surface and the spectra was evaluated by pattern recognition analysis. The classification analysis showed limited capability for discriminating peanuts spiked with aflatoxins at levels below 100 ppb. We have established collaboration with

Dr. Zachary Schultz, whose research focuses on developing new tools for identifying molecules relevant to biomedical diagnostics and other applications and has vast expertise in Raman spectroscopy and techniques such as surface enhanced Raman spectroscopy and tip-enhanced Raman scattering (TERS). We are collaborating in signal enhancements incorporated into our measurements of food contaminants such as mycotoxins. We are working in understanding nanomaterials with plasmonic properties interacting with light to alter the response from nearby contaminant molecules and improve the sensitivity of the Raman technology.

Furthermore, we evaluated a global set of honey and maple syrup samples for authentication based on their spectra generated by the Progeny 1064nm Raman system, allowing to collect spectral data through clear glass/plastic containers to monitor their contents without perturbing the sample. Our results showed that by using an excitation laser of 1064nm minimized the effect of fluorescence and provided sharp and well-resolved bands for identification of potential tampered samples. We identified the prevalence of adulteration in the market with 23% (honey) and 15% (maple syrup) of store-bought samples labeled as “pure” were tainted with other ingredients. Our results were in accordance with reports from JRC Round Table and American Bee Keeping Association that approximately 14-23% of honeys in the market are adulterated.

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

Students are developing skills in spectral collection, chromatographic analysis and data analysis. Our Lab has trained 1 OSU Food Science undergraduate students, Diana Karajeh, that placed first in the undergraduate research competition at the 2021 SHIFT Conference with her work on “DEVELOPMENT OF A RAPID ANALYTICAL TOOL FOR DETERMINATION OF CAPSAICIN CONTENT IN COMMERCIAL HOT SAUCES”. In addition, we graduated one MS student with her dissertation thesis on "Application of Infrared and Raman Sensors in Quality Screening of Maple Syrup and Oat Groats". Finally, we trained the visiting scholar Jorge Mellado that was awarded a Fulbright scholarship for 6 months from the Food, Innovation & Engineering (FoodIE) program at the Departament d'Enginyeria Química, Escola Tècnica Superior d'Enginyeria Química – Universitat Rovira i Virgili (Tarragona, Spain), working on the analysis of Pisco (Peruvian Brandy) for the rapid screening of quality traits using miniaturized spectroscopic sensors.

Amid the difficulties posed by the COVID-19 pandemic, the results of my students have been disseminated at the IFT and SCIX events that target scientific and industrial audiences interested in vibrational spectroscopy and food applications of the technology to monitor quality parameters and detect economic adulteration. In addition, I have been invited to present our technology to various companies that have interest in deploying these handheld/portable devices for in-field data collection.

We continue key collaborations with Thermo Nicolet, Rigaku, Si-Ware, Hamamatsu, Wasatch and Agilent to evaluate the applications of state-of-the-art portable handheld/portable spectrometers for real-time sensing of food.

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

The results from our Hatch project have been disseminated internationally and nationally through events that target scientific and industrial audiences interested in rapid alternatives for monitoring quality parameters and detection of food contaminants. These events provided a perfect setting for exchanging ideas with experts in the field, discuss current work, receive feedback from potential end-users, develop professional and industrial partnerships and disseminate knowledge through multidisciplinary collaborations.

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 will be evaluating the feasibility of using Raman techniques (SERS and TERS) to establish reliable monitoring program(s) for the detection of contaminants in foods. SERS can provide detection and quantification of contaminant levels through spectral signature profiles enabling for high-throughput measurements for controlling the product stream and addressing risk management.

Co-PIs

Christopher Ball, Research Scientist, **The Ohio State University**, College of Engineering ElectroScience Laboratory
614-292-5752 Office ball.51@osu.edu / electroscience.osu.edu

Kevin V. Hackshaw, Chief of the Division of Rheumatology, Department of Internal Medicine, Health Transformation Building
1601 Trinity Street, Bldg. A, Austin, TX 78712. Kevin.Hackshaw@austin.utexas.edu

Zachary Schultz, Associate Professor, Department of Chemistry and Biochemistry, The Ohio State University, 3033c McPherson Lab, 140 W. 18th Avenue, Columbus, OH, 43210. Ph: (614) 292-5775, Email: Schultz.133@osu.edu

M. Monica Giusti, Distinguished Professor, The Ohio State University, CFAES - Food Science and Technology Department
614-247-8016 Office giusti.6@osu.edu osu.edu

Conference Presentations

Jan 4 – Jan 14, 2021. Food Pigments and Advances in Chromatography and Spectroscopy in Food Analysis (Colorantes Alimentarios y Pigmentos” y “Cromatografía Avanzada y Espectroscopia para el Análisis de Alimentos). Open & Doctoral Level Course. Universidad Nacional Agraria, Lima – Peru. Enrollment: 29.

Trends and Emerging Approaches for Authentication of Food Ingredients – The Handheld Spectroscopy Revolution. Conference at Gumushane University. Virtual Presentation. July 6th, 2021. Turkey.

Aplicacion de instrumentos portatiles para la evaluacion de adulterantes y contaminantes de alimentos en campo. Virtual Presentation. Coloquio Pre Congreso CCBIPERU. July 19 – 23, 2021.

SCIX2021 - Chair 21FORENS-02 Food Forensics session. September 26- October1, 2021, Rhode Island Convention Center, Providence, RI.

HONORS AND AWARDS

Winner of the 2021-2022 **Distinguished Teacher Award** - College of Food, Agricultural, and Environmental Sciences and the Office of Academic Programs.

Winner of the 2021 **Lumley Interdisciplinary Research Award** - College of Engineering at The Ohio State University.

Publications

Menevseoglu A, Aykas DP, Hatta-Sakoda B, Toledo-Herrera VH, Rodriguez-Saona LE. **2021**. On-invasive monitoring of ethanol and methanol levels in grape-derived pisco distillate by vibrational spectroscopy. *Sensors* 21(18):6278.

JMellado-Carretero, J.; Aykas, DP.; Puxeu, M.; Varela, S.; Rodriguez-Saona, L.; García-Gonzalo, D.; de Lamo-Castellví, S. **2021**. Application of hand-held near-infrared and Raman spectrometers in surface treatment authentication of cork stoppers. *Food Packaging Shelf Life*. 28: 100680.

Borba, K.R.; Aykas, D.P.; Milani, M.I.; Colnago, L.A.; Ferreira, M.D.; Rodriguez-Saona, L.E. **2021**. Portable near Infrared Spectroscopy as a Tool for Fresh Tomato Quality Control Analysis in the Field. *Appl. Sci.* 11:3209.

Shotts ML, Plans M, Wong K, Milligan AM, Aykas DP, Rodriguez-Saona LE. **2021**. Application of Mid-Infrared Portable Spectrometer for the Rapid Determination of Trans-Fatty Acid Content in Lipid Extracts of Snack and Bakery Products. *J AOAC Int* 104(1):29-38.

Yao, S., Aykas, D. P., & Rodriguez-Saona, L. **2021**. Rapid Authentication of Potato Chip Oil by Vibrational Spectroscopy Combined with Pattern Recognition Analysis. *Foods (Basel, Switzerland)*, 10(1), 42.

[Research to improve gut health to increase agriculture sustainability](#)

Project Director

Ali Nazmi

Organization

Ohio State University

Accession Number

1020804



[Research to improve gut health to improve agriculture sustainability](#)

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

Pioneer colonizing bacteria of poultry can affect chick quality and overall health, including gut and immune function. Assessing changes to animals, as affected by early gut colonization of bacteria, is difficult due to the complexity of host-microbe interactions and the systems affected. This project assessed methods of measuring how pioneer colonizing bacteria affect chick quality and multiple methods of determining their effect on immune function.

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 assessing the influence of early exposure to Enterobacteriaceae and its role in mild gut inflammation, measures of body weight gain (BWG), acute phase protein A1GP, and yolk sac (YS) parameters were more valuable when combined than when analyzed separately. In addition to various measures for gut inflammation, timing also proved to be a valuable component of the assessment. By adding more time points in future experiments, trends in A1GP and yolk sac parameters can be evaluated over time to track the influence of day of hatch (DOH) exposure to Enterobacteriaceae. As evidenced by inconsistencies with BWG and A1GP concentrations between experiments, mild gut inflammation may not produce demonstrable shifts in inflammatory measures.

Therefore, gut specific measures can be added to reveal gut specific inflammation, which may be more sensitive to mild gut inflammation, as opposed to generalized inflammation measures. Since Enterobacteriaceae exposure on DOH may disrupt gut microbial populations just enough to result in minor, nearly undetectable, gut inflammation, utilizing multiple methods, including measures of gut specific and general inflammation, as well as various time points, would strengthen understanding of mild gut inflammation. While the initial hypothesis was that these changes would be seen through two weeks of age, evidence suggested a change to acute phase response, as indicated by fluctuations in A1GP over time, to last through the fourth week of life. While minimal differences in BWG, fluorescein isothiocyanate dextran (FITC-d) recovery, YS retention, YS weight, and both aerobic and Enterobacteriaceae recovery of the YS were noted, it is important to consider that early, low level pathogen exposure may not have major effects on these parameters. Future studies should focus on including additional measures of gut specific inflammation including, but not limited to, changes to inflammatory cytokines on the mucosal surface, alterations in tolerance, and changes in intestinal physiology, to characterize the influence of DOH exposure to Enterobacteriaceae on mild gut inflammation through two weeks of age and beyond. Additionally, analysis on how early pathogen exposure influences microbial populations within the GI tract and immune development should be considered, since this was likely where DOH Enterobacteriaceae inoculation had the greatest impact.

Additionally, we examined the impact of *Citrobacter freundii* (CF) and lactic acid bacteris (LAB) *in ovo* inoculations on total protein (TP), serum protein fractions characterized by serum protein electrophoresis (SPE), and immunofluorescent (IF) staining of dendritic cell (DC) surface receptor CD205 in intestinal tissue. It was hypothesized that *in ovo* inoculums would initiate an acute phase response (APR) that could be captured and characterized via changes in α , β , and γ fractions characterized through SPE, and that inoculums would activate dendritic cells resulting in migration to diffuse secondary lymphoid tissue including ileal Peyer's patches. Significant changes were noted in β 1 and β 2 fractions following SPE for all three replicate experiments. A lack of changes in α fractions was unexpected as several acute phase proteins within this fraction are associated with bacterial infection in poultry. One potential explanation for these results are the variable half-lives of the multitude of acute phase proteins secreted during the APR. In particular, the β fraction transferrin, ovotransferrin in the chicken, has a much longer half-life of 8-10 days relative to some α fraction which have half-lives between 2-5 days in mammals though limited information is available regarding these half-lives in chickens. It is possible that *in ovo* inoculations did elicit an early APR, but by 10 days of age, only artifacts of β fraction were remaining in circulation prior to eventual clearance while α fraction had already been cleared from circulation. More importantly, the lack of persisting changes in these fractions at 10 days of age could also suggest that *in ovo* treatments did not induce a state of chronic inflammation accompanied by prolonged acute phase protein secretion, but instead may have induced a state of tolerance to the pioneer colonizing isolates. Due to multiple contributing APR proteins with unique peak response times and half-lives, assessing serum composition at a single timepoint via SPE is not a reliable means for capturing cumulative responses. An alternative would be to assess serum via SPE at multiple timepoints from the time of introduction of inflammatory stimuli until a resolution of total responsiveness is observed. However, with respect to these goals of these experiments, SPE did help to narrow a list of serum biomarkers of inflammation to β fraction proteins for future pursuit and corroborated the findings of others.

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

Significant progress was made in developing assays to assess gut health, especially related to host-microbiota interactions and the influence of pioneer colonizing bacteria on immune function. It appears that colonization by Enterobacteriaceae may be inducing a state of tolerance. While this can be useful in terms of asking the immune system to ignore non-harmful components within the gut, it can also allow opportunistic and food safety pathogens to persist, which includes bacteria that cause inflammation. Scientists and veterinarians can use this information to further study the impact of gut health treatments on animals and to begin trying to alter pioneer colonizing bacteria to improve disease resistance.

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

By establishing methods to measure and begin to understand the role of pioneer colonizing bacteria on gut health, the broader audience benefits from improved sustainability of animal agriculture through reduced disease and improved feed to gain ratio.

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.

Opportunities for professional development –

Students worked with collaborators to learn new laboratory techniques and interacted with other scientists in the field while attending scientific conferences related to the topic.

Disseminations of results –

Results were presented at the International Poultry Scientific Forum and the Annual Meeting of the Poultry Science Association, as well as published as research articles.

Publications –

Rodrigues, D.R., K.M. Wilson, L.R. Bielke. 2021. Proper immune response depends on early exposure to gut microbiota in broiler chicks. *Frontiers Physiology*. <https://doi.org/10.3389/fphys.2021.758183>

Chasser, K.M., K. McGovern, A.F. Duff, M. Trombetta, B.D. Graham, L. Graham, W.N. Briggs, D.R. Rodrigues, and L.R. Bielke. 2021. Enteric permeability and inflammation associated with day of hatch Enterobacteriaceae inoculation. *Poult. Sci.* 100:101298

Chasser, K.M., K. McGovern, A.F. Duff, B.D. Graham, W.N. Briggs, D.R. Rodrigues, M. Trombetta, E. Winson, and L.R. Bielke. 2021. Evaluation of day of hatch exposure to various Enterobacteriaceae on inducing gastrointestinal inflammation in chicks through two weeks of age. *Poult. Sci.* 100:101193

Goals for next reporting period –

During the next reporting period, further refinement of gut health assessment assays and influence of vertical transmission of bacteria from parent stock to progeny will be investigated.

[Evaluating Economic Trade-offs among Food Waste, Food Safety and Human Nutrition](#)

Project Director

Brian Roe

Organization

Ohio State University

Accession Number

1014124



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

Food waste often represents an inefficiency in the food supply chain. The U.N. identifies food waste as an important component of food insecurity in their Zero Hunger Challenge. However, food waste proves difficult to address in many countries. However, consumers are being asked to address several other food issues including to handle foods in a manner that minimizes the chances and severity of foodborne illness and to make food intake decisions that support nutrition. In some cases the actions that might seemingly forward one goal could frustrate another goal. For example, simple reminders to consumer that they should reduce food waste might induce consumers to 'clean their plate' and, in the absence of strict portion control during food preparation and commensurate purchasing discipline, could lead to consuming additional calories that increase the odds of undesirable nutrition outcomes such as obesity. As another example, strict adherence to the label dates on purchased food ingredients in an attempt to reduce the odds of foodborne illness may stimulate food waste. The overall objective of this proposal is to understand more about the process households use to make decisions about food purchasing, preparation and consumption and to improve our understanding of how interventions designed to address one of these three goals (reducing food waste, improving food safety or enhancing nutrition) might affect progress towards the other goals. Increased understanding of this decision making process and potential behavioral conflicts faced by consumers can improve education and policies concerning food purchasing, handling and consumption that might best address all three objectives simultaneously.

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 use national survey data from July 2020 to understand the food acquisition, preparation, and management strategies that American households implemented in response to the COVID-19 pandemic. We find a substantial increase in the amount of food prepared and consumed at home which scales with respondents' time availability, perceived risks of dining out, and pandemic-induced income disruption. We then identify several household responses to support this increase in home food consumption that are in line with practices suggested to enhance resiliency at other links in the food supply chain, including increased cold storage capacity and enhanced in-house capability via improved cooking and food management skills. We discuss how responses such as improved food skills can reduce the propagation of shocks through the supply chain by allowing greater flexibility and less waste, while actions such as increased home cold storage capacity could undermine system resilience by exacerbating bull whip effects, i.e., amplifying consumer demand shocks that are propagated to upstream food supply chain actors.

In another effort, we worked to improve our ability to measure household food waste among U.S. households by adapting an online survey validated with European households for American audiences and then validating its use via a pilot study with households from across the continental United States. We find that a sample of 150 online panelists provided sufficient statistical power to replicate standard findings from the literature that smaller households and older respondents generate less food waste, but not enough statistical power to identify a statistically significant week-to-week reduction in reported food waste among households who received a food waste message rather than a control message. Power analysis conducted via bootstrapping with the pilot data suggests a usable sample size of 180 per group is required, providing guidance for other researchers who require a cost-efficient and convenient approach to measuring household food waste.

In another effort, we detail accounts of losses from several distinct fresh tomato supply chains in the United States with the goals of understanding the drivers of produce lost in the field and other early supply chain segments and of assessing the potential for policies and programs aimed at reducing these losses. Two key factors arise as drivers of loss across the three case studies considered (one in Florida and two in California) --the market and the natural environment. These factors are interrelated: environmental events can impact price, and market conditions impact the degree of damage from environmental factors that buyers will accept. A preoccupation of growers is developing strategies and expertise for mitigating these factors. Labor scarcities, policy issues, buyer specifications, consumer preferences, and production costs also arose as highlighted loss drivers. Given that the landscape of opportunities and challenges will evolve with technological and institutional factors, we argue that the need for input from relevant stakeholders and field testing is crucial in advance of the promotion and scaling of any suggested interventions.

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

We provided policy makers and food system practitioners insights about the role of COVID in the generation of household food waste. We provided researchers and practitioners a simple, validated instrument that can be implemented online to US households to reliably measure their household food waste levels and guidance as to the needed sample size to yield reliable

estimates. We provide policy makers and agribusinesses with an outline of opportunities and challenges facing farm-level reductions in fresh tomato loss and identify the types of input needed from relevant stakeholders and field testing that will be crucial in advance of the promotion and scaling of any suggested food loss interventions.

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

The creation of the U.S. household food waste measurement survey instrument will pave the way for a consistent method to measure food waste among U.S. households, permitting easier and more consistent assessment of the efficacy of numerous household food waste interventions. This will permit prioritization of intervention efforts that can inform the formation of national food waste reduction strategies. Reducing food waste yields numerous public benefits, including reduced environmental impacts, reduced food prices, and decreased food insecurity.

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.

Two graduate students have received training in methods related to the measurement of food waste and economic analysis of the reasons for waste. Journal articles and invited presentations to communities of policy makers and practitioners (both live and via webinar) have occurred. Media interviews have also publicized several sets of results. Article summaries have been posted to the investigator's site dedicated to food waste (<https://u.osu.edu/foodwaste/>). We will continue to analyze data that is currently available and collect additional data to refine insights from recent published work.

Dissemination included the following peer-review journal articles and professional presentations:

Roe, Brian E. (2021) "Progress and Challenges in Empirical Food Waste Research: A Commentary on 'Estimating Food Waste as Household Production Inefficiency,' and 'Household Food Waste and Inefficiencies in Food Production.'" *American Journal of Agricultural Economics*, 103(1):22-25. <http://dx.doi.org/10.1111/ajae.12163>

Shu, Y., Roe, B. E., & Bender, K. (2021) "Adapting, Refining and Expanding a Validated Questionnaire to Measure Food Waste in US Households." *MethodsX*, 8, 101377. <https://doi.org/10.1016/j.mex.2021.101377>

Bender, K.E., A. Badiger, B.E. Roe, Y. Shu, D. Qi. (2021) "Consumer Behavior during the COVID-19 Pandemic: An analysis of food purchasing and management behaviors in U.S. households through the lens of food system resilience," *Socio-Economic Planning Sciences*, <https://doi.org/10.1016/j.seps.2021.101107>

Baker, Greg, Calvin, Linda, Gillman, Anne, Kitinoja, Lisa, Osland, Travis, Pearson, Pete, Prezkop, Leigh, Roe, Brian E., Spang, Edward, and Tooley, Jean B. "Tomato Tales: Comparing Loss-Reduction Drivers and Opportunities across U.S. Fresh Tomato Supply Chains." In *The Economics of Food Loss in the Produce Industry*. Travis Minor, Suzanne Thornsberry, and Ashok K. Mishra (eds.) Routledge Publishing, London, chapter 10.

Roe, Brian E. "Existing Efforts in Measuring and Modeling Early Value-Chain Food Losses." In *The Economics of Food Loss in the Produce Industry*. Travis Minor, Suzanne Thornsberry, and Ashok K. Mishra (eds.) Routledge Publishing, London, chapter 3.

Qi, D., R. Li, J. Penn, B. Houghtaling, W. Prinyawiwatkul, B.E. Roe. 2021. "The Efficacy and Interactions of Nudges to Reduce Restaurant Plate Waste and Improve Vegetable Intake: A Field Experiment," *AAEA & WAEA Joint Annual Meeting in Austin, TX, August 1-3*.

Qi, D., Bailey Houghtaling, Jerrod Penn, Witoon Prinyawiwatkul, and Brian E. Roe. 2021. "Vegetable Forward: Does vegetable consumption improve when more vegetables are selected?" *10th Annual Conference of the American Society of Health Economists, June 21 - 23, Zoom*.

Qi, D., R. Li, J.W. Apolzan, B.E. Roe. 2021. "Market Liberalization, Dairy Intake and Adolescent Height: Results from the Chinese Health and Nutrition Study, 1991 - 2009." *Selected Poster, American Economic Association, Allied Social Science Association Virtual Annual Meetings, Jan. 3-5, 2021*.

Community Nutrition Education and Obesity Prevention

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7002734



Community Nutrition Education Programs - 2021 Results

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

According to the State of Obesity 2021 report, 15.7% of youth ages 10-17 and 35.5% of adults in Ohio were considered obese. Ohio is ranked 14th in the United States for overweight and obese adults. According to Feeding America, 13.1% of people in Ohio face hunger and food insecurity issues, which is one in eight people.

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.

Since 1969, OSU Extension has implemented the EFNEP program and since 1996 it has been the sole implementing agency for the SNAP-Ed program. These two federal nutrition education programs are focused on teaching eligible audiences to choose and prepare foods of high nutrient value and manage food resources to decrease food security. Specifically, for youth obesity prevention, embracing comprehensive evidence-based strategies delivered through community-based education and public health approaches. Funding for the SNAP-Ed program is consistently one of the largest awards at Ohio State and reaches tens of thousands of participants (children and adults) in every county across the state. OSU Extension SNAP-Ed program assistants teach classes on nutrition, physical activity, food safety, and purchasing food on a budget. SNAP-Ed implemented a social marketing campaign in 2019 called "Celebrate Your Plate" (CYP).

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

In 2021 most nutrition education classes continued to be offered online, in which 23,788 youth and 2,441 adults were reached through face-to-face and online nutrition education programs. Ninety-five percent (95%) reported improvement in diet quality, 85% report better food resource management practices, more than 50% of participants reported eating more fruits and vegetables. Also reported were significant pre/post increases in meal planning, buying healthy foods on a budget and confidence that food will last through the month. The CYP Social Marketing Campaign increased impressions by 1,309% and reach by 21%.

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

Using a research-based, interactive approach, peer educators from the communities they support reach over 25,000 limited-resource families and youth each year. More than 80 percent of EFNEP families report living at or below 100 percent of poverty. Positive impacts of EFNEP include family engagement, saving money, increasing intake of fruit and vegetable consumption and an increase of physical activity.

Through SNAP-Ed classes participants learn to select, prepare, and incorporate fruits and vegetables, whole grain, low-fat protein foods and low-fat dairy products into a healthy diet; to use limited resources to plan, purchase, and prepare food for the family; to be physically active every day; and to store and handle food so it is safe for consumption. At Ohio State SNAP-Ed, is one of the largest awards at the university and reaches tens of thousands of participants (children and adults) in every county across the state.

Mental Health Literacy Programs

Project Director

Deborah Lewis



Mental Health Literacy 2021 Program Results

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

According to the National Alliance on Mental Illness, approximately 16% (1.9 million) of Ohioans have a mental health condition. In Ohio, about 478,000 adults aged 18 or older (4.1% of all adults) have a serious mental illness (SMI) within the year prior to being surveyed. Mental health awareness is therefore, an important issue for all educators and community members who engage the public, as they are often the first line of defense for their participants. Education professionals have recognized the impact that a participant's mental health has on relationships, productivity, and achievement and they realize that there is a great deal that can be done to help people with mental health issues.

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.

Of particular concern - many mental health professionals are not trained, nor do they have direct experience working with the agricultural sector and their unique challenges. OSU Extension has partnered with the Ohio Department of Agriculture to meet this need. Our Farm and Ranch Stress Certification courses are targeted at mental health care professionals seeking to better understand the stressors of farm and ranch life. The lack of knowledge surrounding the agricultural industry is an identified barrier to mental health care for farmers and ranchers.

In 2018, OSU Extension had its first instructors certified to teach and train trainers in Mental Health First Aide (MHFA) and in 2019, Trauma Informed Care (TIC) was added. Also in 2019, a "Rural and Farm Stress Task Force" was formed. In 2021, a "Behavioral Health Field Specialist" position was created in Agriculture and Natural Resources to guide programming efforts in mental health literacy in the agricultural community.

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

In 2021, certified Extension professionals trained:

- 268 4-H Club Advisors in a "Mental Health Series Webinar Series"

- 182 adults in Mental Health First Aid (Adult MHFA)

- 60 adults in *Question, Persuade, Refer* (QPR Suicide Prevention)

- 74 adults in Trauma Informed Care

- 414 adults in Youth Mental Health First Aid (YMHFA)

In addition, multiple programs were offered on dealing with stress (e.g., "Bury Seeds Not Stress", "Communicating About Stress: Knowing When to Ask for Help", "Coping with COVID", etc.), which were attended by 282 participants.

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

OSU Extension provides training for Extension professionals to become Certified Adult Mental Health First Aid Instructors and offers trainings in Mental Health First Aid for employees at Ohio State and members of the agricultural community to learn about the warning signs and symptoms of mental health issues. We also are helping to raise mental health awareness and

advocacy on a national scale and have distributed nearly 25,000 copies of the 4-H project book *Your Thoughts Matter: Navigating Mental Health*, since its introduction in 2017. That includes 20,500 sold nationally and authors Jami Dellifield and Amanda Raines have contributed to other National 4-H mental health curricula as well.

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

The Ohio Farm Bureau Foundation recognized Jami Dellifield with the first ever Yvonne Lesicko Perseverance Prize, or Y Prize for short, for her innovative work on farmer mental health initiatives.

Dellifield serves as a Family and Consumer Sciences educator with Ohio State University Extension's Hardin County office. After seeing the stress effects of farm life on producers in her area, Dellifield led the charge of bringing farmer mental health to the forefront of her efforts. Dellifield took it upon herself to find training and resources – not just for herself, but for others in OSU Extension to address farm stress issues.

The Y Prize is a new award created by the Yvonne Lesicko Memorial Fund. The fund was created in 2020 to honor Yvonne Lesicko, former vice president of public policy for Ohio Farm Bureau. The fund, within the Ohio Farm Bureau Foundation, was established to support the causes and initiatives that were important to Lesicko.

“I am beyond honored to be a part of this as I think about all of the amazing things that Yvonne did to keep the mental health of farmers and our entire community a priority,” Dellifield said. “She was a true leader and did so much for this very important issue for agriculture.”

Dellifield is a trainer and an advocate for mental health literacy programs such as Mental Health First Aid and Question, Persuade, Refer (QPR), where the focus is on improving knowledge of signs and symptoms of mental health and substance use problems. She has taught well over 1,000 farmers and farm youth around the state and has also been a trainer for professionals working with farm communities.

As the 2021 Y Prize award winner, Dellifield will be given a platform to share her work and the efforts of Ohio State University Extension for farm stress and mental health. Dellifield will be a presenter at the 2022 Young Ag Professionals Winter Leadership Experience. All of this is part of the award's goal of lessening the stigma surrounding mental health issues.

Video presentation/interview: <https://youtu.be/fuW2rc5he9s>

Discovery and development of insecticides with novel mechanisms of action for mosquito control

Project Director

Peter Piermarini

Organization

Ohio State University

Accession Number

1013867



Result 1

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

Mosquitoes are 'the most dangerous animals on earth' because they transmit deadly pathogens to humans, including protozoans (e.g., malaria parasites), arboviruses (e.g., Zika virus), and filarial nematodes (e.g., filariasis). Unfortunately, only a limited number of insecticides are available for public health use, which has led to insecticide resistance. To overcome the challenge of insecticide resistance in mosquitoes and control the spread of emerging mosquito-borne arboviruses, we will develop a new generation of insecticides that will kill mosquitoes via unexploited mechanisms.

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 discovered a novel and natural product that is equally efficacious as an insecticide against insecticide-susceptible and insecticide-resistant strains of mosquitoes. We generated insights into how this product causes insect mortality by conducting *in vitro* physiological assays on mosquito tissues. We found that the natural product disrupts an aspect of mosquito physiology not previously exploited by other insecticides, suggesting a unique mode of action. Collaborations with chemists have allowed us to identify key chemical features of the natural product that contribute to its insecticidal activity. We are currently attempting to build upon these insights to generate novel derivatives of the natural product that exhibit superior insecticidal activity against mosquitoes.

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

My target audience of academic researchers benefited from publications and presentations, which provide new insights into mosquito physiology and highlight novel avenues for developing chemical control agents to manage mosquito populations.

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

The broader public benefited by my project's revealing of basic insights into mosquito physiology and toxicology, which will lead to the development of novel chemical tools for protecting the public from the nuisance and disease transmission caused by mosquitoes.

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.

Peer-reviewed journal publications in 2021:

1. Aretz C, Kharade SV, Chronister K, Trigueros RR, Rodriguez EM, **Piermarini PM**, Denton JS, Hopkins CR (2021) Further SAR on the (phenylsulfonyl)piperazine scaffold as inhibitors of the *Aedes aegypti* Kir1 (*AeKir*) channel and larvicides. *ChemMedChem* 16: 319-327. doi:10.1002/cmdc.202000598.
2. Kalsi M, Walter A, Lee B, DeLaat A, Trigueros RR, Happel K, Sepesy R, Nguyen B, Manwill PK, Rakotondraibe LH, **Piermarini PM** (2021) Stop the crop: Insights into the insecticidal mode of action of cinnamodial against mosquitoes. *Pestic Biochem Physiol* 171: 104743. doi:10.1016/j.pestbp.2020.104743.

Research Presentations in 2021:

Piermarini PM (2021) Discovery of novel chemical tools for controlling the most dangerous animals on Earth. Invited seminar, Department of Biology, Valparaiso University (presented on-line).

Li Y, **Piermarini PM** (2021) Putative role of renal (Malpighian) tubules in regulating calcium homeostasis in the mosquito *Aedes aegypti*. Submitted poster, Ohio Physiological Society Annual Conference. Cleveland, OH.

Graduate and Post-Doctoral Advising in 2021:

MS students:

Yuan Li (Received Grants in Aid of Research from Sigma Xi and Ohio Mosquito Vector Control Association)

- **List of Visiting Scholars advised and their institution:**

Dr. Gujjari Lohitha (National Institute of Pharmaceutical Education and Research, India).

Teaching Efforts

I taught an on-line Veterinary Entomology course in the Spring, Summer, and Autumn 2021 semesters. A total of 592 students enrolled and were introduced to the biology of insects and arachnids that transmit diseases to domestic animals and disrupt animal production.

On-line Certificate Course Development:

In 2021, I revised and expanded 3 on-line certificate courses for continuing education credit with assistance from OSU Extension.

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.

Dr. Piermarini and collaborators in the OSU College of Pharmacy have identified unique chemicals from the *Cinnamosma* plant that are toxic and repellent against mosquitoes and outperform most current repellants (e.g. DEET). These new, plant-based chemicals have the potential to protect people from mosquitoes that transmit Zika virus and other mosquito-borne diseases, such as malaria, dengue fever, West Nile fever, and chikungunya fever, which collectively debilitate the health and well-being of hundreds of millions of people around the globe each year. This naturally based compound could eventually replace harmful, synthetic insecticides.

Critical Issue

OSU - Thriving Across the Lifespan

Education Course for Divorcing Parents of Minors - Successful Co-Parenting

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7002733



Education Course for Divorcing Parents of Minors – Successful Co-Parenting 2021 Program Results

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

When parents divorce, the children often pay the highest price. Of the approximately 29,000 marriages that break up in Ohio each year, nearly 43% involve minor children (Ohio Department of Health, 2020 Marriages & Divorces Report). The term “co-parenting” refers to the cooperative process of parenting together while living apart. Co-parenting allows a child or children to have a secure upbringing without conflict of interest. Co-parenting enables the child or children of divorce to maintain a healthy close relationship with both parents.

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.

Family and Consumer Sciences' *Successful Co-Parenting* is a two- to three-hour class (face-to-face or online) designed to equip parents with the knowledge, skills, tools, awareness and strategies to help their children adjust to divorce now and in the future. Parents who participate in this program learn how to foster resiliency to the challenges of divorce, helping their children to recover from or return to previous functioning after encountering the challenge faced by their parents' divorce/separation. Parents can foster resiliency by: moving on after divorce toward personal growth; developing a healthy, stable relationship with their child; establishing proper boundaries with their child; and having minimal conflict with their co-parent – all of which are skills and techniques taught in the class.

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

In 2021, more than 1200 participants took part in the *Successful Co-Parenting*® (SCP) program. Approximately 1,000 of those took the *SCPOnline*®, which was developed in 2019 as an affordable and easy-to-navigate online course available to anyone anywhere in Ohio and beyond. Ninety-two percent (92%) of participants report being more prepared to co-parent as a result of the program; 95% report learning new information and 97% plan to use the information that they learned in the class.

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

Divorce affects approximately 28,000 children under the age of 18 in Ohio each year. The Successful Co-Parenting Class, regardless of whether it is taken at the beginning of the separation process or near the end of the divorce process, benefits all separating couples who have minor age children, including those who have cohabited and never married. Research tells us that there are great benefits to children and their parents when co-parents work together in a civil and purposeful way to raise their children. Research suggests that children of divorce are at greater risk of lower school success, behavior problems, depression and anxiety, and their own future divorce. Research has consistently noted the learning benefits parents experience by participating in a co-parenting class. For instance, studies have found that parents reported increased knowledge about how to reduce and resolve conflict with the other parent and useful ideas for reducing stress in children. As parents make improvements in their ability to communicate effectively with each other and resolve conflict, the level of tension between them is likely to decrease and reduce tension among parents will then reduce the level of harmful stress on children.

Source: <https://scponline.osu.edu/about-scp-online/>

Financial Literacy Program for Youth

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7002641



Financial Literacy for Youth - Real Money. Real World. 2021 Program Results

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

One of the most important life skills young people will need to succeed as adults is resourceful money management. OSU Extension developed the *Real Money. Real World.* curriculum designed to: 1) increase youth awareness of how education level and corresponding career choice influence personal income and financial security; 2) increase youth knowledge of money management tools used in daily spending for cost-of-living decisions; and 3) increase youth awareness of how income and lifestyle choices affect the amount of money available for discretionary spending.

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.

Middle and high school age youth learn basic money management practices in the classroom and then make simulated lifestyle and budget choices through a spending simulation. During the spending simulation, youth assume the role of a 27-year-old adult. They receive an occupation, monthly salary, and the number of children they are to raise. Community volunteers staff booths that represent actual businesses in the community. The curriculum was updated in 2020 and has been adopted by 70 of Ohio's 88 counties in 2021.

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

In 2021, approximately 14,000 youth participated in the *Real Money. Real World.* program and 765 adult volunteers were engaged in staffing the simulation booths (e.g., insurance company, bank, child care facility, utility company). Of the sampling of 2,161 youth who completed the end of program evaluation, 72.3% reported a positive change in understanding deductions taken from paycheck; 61% reported a positive change in understanding the costs to maintain a household and the importance of having a spending plan; and 66.7% reported a positive change in understanding the costs to care for a child.

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

Ohio Treasurer Robert Sprague has partnered with OSU Extension's Family and Consumer Sciences and 4-H Youth Development professionals to advance and expand the use of the college's *Real Money. Real World.* financial literacy program statewide. The announcement coincides with the annual America Saves Week, which aims to raise awareness about financial literacy education while helping individuals to achieve financial stability. Approximately 14,000 Ohio youth take part in the experiential financial literacy program each year.

Ohio 4-H Youth Development

Project Director

Deborah Lewis

Organization

Ohio State University

Accession Number

7000197



Ohio 4-H Youth Development 2021 Impacts

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

Ohio State University Extension is committed to helping Ohioans thrive across their lifespan; in 4-H we are committed to helping young people develop skills that will help them succeed. Our goals are to empower youth to develop and expand characteristics, knowledge, and skills that create a strong foundation for a positive adulthood, including career and college readiness. We develop and strengthen the skills of current and future leaders to address today's most pressing issues.

In 4-H, youth (ages 5-18) learn by doing projects that are designed to fit their needs at different ages. Through a variety of projects - from food and forestry to rockets and rabbits - 4-H gives children and teens opportunities to learn life skills, to practice them, and become confident in their ability to use them in the future. 4-H teaches young people how to meet their needs for belonging, mastery, independence, and generosity in positive ways. More specifically, 4-H programming is built around Eight Essential Elements, sometimes also called the Eight Key Elements:

1. A Positive Relationship with a Caring Adult
2. An Inclusive Environment
3. A Safe Emotional and Physical Environment
4. Opportunity for Mastery
5. Engagement in Learning
6. Opportunity to See Oneself as an Active Participant in the Future
7. Opportunity for Self-Determination
8. Opportunity to Value and Practice Service to Others

Ohio 4-H works with young people in a variety of settings including schools, day camps, overnight camps, afterschool care, clubs, and other learning environments. Regardless of the environment, we rely on the experiential learning model in which learning takes place when youth experience, share, process, generalize, and apply a particular practice, idea, or piece of information. All 4-H programs focus on active involvement and quality experiences, which stimulate lifelong learning of values and skills.

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 Ohio 4-H Youth Development Program enrolled 84,330 youth members in 2021. Of those, 58,188 participated in clubs, 16,436 were reached through school-based programming, and 11,314 participated in 4-H camps. 2021 continued to be a challenging year for all, but 4-H youth are resilient! Virtual programs, club meetings, service learning, project judging, camps and fairs all contributed to youth gaining skills they will use long after their 4-H membership ends. Included here is a link to the "Ohio 4-H Youth Development 2021 Impact Report": <http://go.osu.edu/OH4-H2021impact> and the "2021 Ohio 4-H Stats" infographic <https://go.osu.edu/OH4-H2021Stats>

Financial impact of Ohio's adult 4-H volunteer time contribution:

- Using an average of 10 hours per month of donated volunteer time for 2021, and a value of Ohio volunteer time at \$28.54/hour (2021 data, from the Independent Sector):

- 10 hours x 12 months = 120 hours/year

- 120 x \$28.54 = \$3425 per year per volunteer

- \$3425 x 12,042 adult 4-H volunteers = \$41,243,850 of donated time.

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

One 2021 program highlight is our continued partnership with Apple, which began in 2019. As part of its Community Education Initiative, Apple provided the Ohio 4-H Youth Development Program with devices, programmable robots, and professional learning and support. Apple's gift of \$1.2 million in devices and technology to OSU Extension has given our current 4-H staff access to technology needed to reach 6,274, 4-H youth in 44 counties in 2021. More than 64% of the youth reached are new to 4-H, so this partnership with Apple has given access to new youth across Ohio to connect with 4-H programming. OSU Extension 4-H professionals teach youth in K-12 coding and creativity using the technology provided by Apple. Clovers CODE (Creating Opportunities Designed for Everyone) helps youth become content creators using technology rather than just content consumers of technology. Ohio 4-H is preparing youth for future career opportunities through the Clovers CODE program.

Knowledge of the science of genetics, nutrition, management, handling, and environment in relation to the youth's food animal projects plays a critical role in the success of producing safe and wholesome food products for consumers. By participating in learning activities designed to help ensure their food animals are well cared for and that their products are safe for consumers, junior fair exhibitors and their families will understand the important linkages among their responsibilities, obligations, public perceptions and consumer confidence in assuring well-cared-for animals and quality products. The Ohio Department of Agriculture (ODA) requires all youth exhibiting food animal projects to participate in quality assurance programming. OSU Extension provides leadership for implementing quality assurance programming in partnership with ODA, FFA and County Agricultural Societies' Senior Fair Boards. When Tracy Winters, 4-H educator in Gallia County, realized that resale prices of fair market animals were dropping due to poor meat quality, she was determined to find a solution for her 4-H members. She knew education was key, and with the assistance of an Ohio 4-H Foundation grant, she designed a series of trainings for youth to learn how their actions as livestock producers affect the quality of their product. From experts with the CFAES Department of Animal Sciences, Ohio 4-H members learned about food safety and the ethical considerations that go into raising quality meat. They were also able to take animal quality assurance training in small-group settings. This required training teaches youth best practices when dealing with food animal production. Six training sessions were held throughout April and May, with 320 4-H and FFA youth participating along with their parents. Kits created with the grant funds provided youth with hands-on activities used in club settings and large-group demonstrations. The result? "Youth

didn't realize their practices were hurting the quality of their products," said Winters. "They learned how stress can affect meat products, and our program evaluations reflected a change in youth attitudes, especially when thinking about transporting animals and while on the fair grounds."

source: "Ohio 4-H Youth Development 2021 Impact Report": <http://go.osu.edu/OH4-H2021impact>

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

OSU Extension research shows that Ohio youth credit their 4-H clubs with making them better citizens, leaders, and communicators. Research from Tufts University shows that 4-H youth are competent, confident, caring, and connected, and that they exhibit strong character. The Tufts study shows that 4-H'ers contribute more to their families and communities, achieve higher grades in school and are more likely to go to college than youth who are not in 4-H, or even youth who participate in other out-of-school programs. In addition, youth involved in 4-H lead healthier, more productive lives, are less likely to suffer from depression and are less likely to participate in risky behaviors like drinking and smoking.

Type

Projects / Programs

Projects / Programs without a Critical Issue

0

Not Provided