

# Wisconsin (University of Wisconsin Madison) Annual Report - FY2021

## Report Status: Approved as of 07/08/2022

### Contributing Organizations

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University of Wisconsin Madison

### Executive Summary

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#### Overview

At the University of Wisconsin-Madison, the Wisconsin Agricultural Experiment Station (WAES), which is part of the College of Agricultural and Life Sciences (CALs), and the Division of Extension (Extension) are partners who work together to generate new and exciting research-based knowledge. The partners then deliver that knowledge to Wisconsin's residents and communities to help address the challenges outlined in our Critical Issues.

#### Scope of Education & Research

Smith-Lever funding provides about a fifth of Extension's annual funds, and Hatch funding provides an estimate of 7 percent of annual research funds for CALs/WAES-same as last year. However, this funding provides the vital basis for research-based information and programming to individuals, communities, businesses, and local governments in Wisconsin. In addition, Smith-Lever funding provides the legal basis for additional funding provided by the State of Wisconsin. To reflect the vital nature of NIFA Capacity Funds for the people of Wisconsin, this report includes information from all programmatic activities at WAES and Extension.

- **WAES:** For 2021, WAES supported 112 projects that covered all aspects of agriculture, dairy, food accessibility, nutrition, natural resources, as well as educating rural farmers and communities. In the midst of the pandemic, CALs was able to officially open the Meat Science and Animal Biologics Discovery building. This new and exciting endeavor will pave the way for new and innovative research in meat production, food safety, human health, and animal bio-products. This new building has ushered in a growing number of partnerships with the private sector, both in meat processing and food safety. New faculty starting in the facility will be working on biologics derived from animals.
- **WAES:** Another exciting expansion is of Babcock Hall, our food science building, and the construction of a new home for the Center for Dairy Research. Although the project is not complete, our Center for Dairy Research has moved into their new space and continued their work on specialty cheeses, new beverages and other dairy foods innovations. The center expects a large increase in industry partnerships due to the demand for the capabilities of its new pilot plant. The department of Food Science has several capacity grants that will benefit from this expansion.
- **WAES, Dairy Innovation Hub (DIH) updates:** The DIH has now funded over 100 projects on the three UW campuses. At Madison, we have to date hired five faculty on this initiative in dairy economics, rumen microbial physiology, dairy foods for human health, and land and water stewardship. The new faculty within this hub will eventually contribute to our capacity fund research.
- **WAES:** Awarding seed grants locally to enhance competitiveness for extramural grants. Federal-formula Agricultural Experiment Station capacity funds (Hatch funds): Over the last eight years, \$6.4M in capacity funds supported projects that then garnered over \$45M in federal competitive grants from USDA-NIFA, NSF, NIH, NASA, EPA and CDC to researchers in almost every CALs department.
- **Extension:** In 2021, Extension educators and researchers have reported over 510,000 outreach contacts. This includes participants from programs funded by state funds, federal funds, grant funds and nutrition education programs (EFNEP and SNAP-Ed). Extension staff and faculty have worked with over 1,100 partnering organizations and businesses to execute our outreach mission. Our mission is to empower the people of Wisconsin. To this end, we mobilize, educate, and support approximately 11,000 volunteers across the State of Wisconsin, supporting them in protecting and improving Wisconsin's communities, businesses, and natural resources. Our flagship volunteer programs focus on youth development (Wisconsin 4-H), the preservation of Wisconsin's natural resources (Wisconsin Master Naturalist Program; Wisconsin Water Action Volunteer Program) and the support of local food systems and vibrant communities (Wisconsin Master Gardener Program). In 2021, Extension volunteers provided over 350,000 hours of service; this is the equivalent of approximately 175 full-time employees.

## **Administrative Updates**

### **Division of Extension: Leadership Team**

In 2021, Extension has hired its first Chief Diversity Officer, and has filled the thus-far interim position of the Associate Dean for Youth, Families & Health. Extension has also filled the vacant Associate Dean of Policy, Operations and Stakeholder Engagement position. This concludes the staffing of Extension's leadership team that was initiated as part of Extension's comprehensive reorganization process, and Extension's merger from UW-System to UW-Madison.

### **Division of Extension: Funding Portfolio Diversification**

In partnership with the University of Wisconsin Foundation, we have hired our first Senior Director of Development. The Senior Director of Development leads Extension's effort to diversify its funding portfolio through philanthropy in order to further leverage capacity funding.

### **Division of Extension: State Funding Increases focusing on Agriculture Production**

Extension has initiated the process of filling 11 new positions that will focus on supporting Wisconsin's agriculture industry. In 2021, Wisconsin Act 58 provided funding for Extension outreach specialists and CALS integrated Extension faculty. Through this, Extension has received 1 Million USD annually from the State of Wisconsin to address agricultural needs related to beef, swine, grazing, water quality, farm management, and other critical topics.

### **Division of Extension: Strategic Planning Process**

The Division of Extension is engaging in a strategic planning process in 2022. This work will result in a Strategic Plan to guide our division over the next five years. The estimated timeline for the planning team efforts is 6-8 months, targeting completion of the work in late 2022. The process will include engaging constituents who will inform the plan, including Tribal Nations, external partners and customers, and internal faculty and staff. The Strategic Plan will:

- Identify internal partners that need to engage in and understand our strategic direction;
- Identify current external partners, potential partners, and Tribal Nations that can provide us with their perspective of desired services aligned with our purpose
- Provide an implementation plan, including suggested metrics to measure success.

### **CALS/WAES: Leadership Transition**

CALS Dean and WAES Director Kate VandenBosch will step down as dean in summer of 2022, and search for a new dean is underway. We expect the selection to be made in May of 2022. Also, CALS Associate Dean for Research and Associate Director of WAES Bill Barker retired in 2021. Jeri Barak, who is a professor of plant pathology, is serving a two-year term as associate director of WAES.

### **CALS: Focus on Diversity, Equity and Inclusion Efforts**

1. Establishing an Equity, Diversity and Inclusion Office. The college created the new position of Associate Dean for Diversity, Equity, and Inclusion and hired Dr. Louis Macias, who will serve as our chief diversity officer. Macias will lead the development of strategic equity, diversity, and inclusion priorities, support CALS units in their EDI priorities, and support professional development of CALS personnel in EDI training and capacity-building.
2. Implementing best practices in hiring to avoid bias and promote equity and diversity for all faculty, leadership and administrative position searches
3. Following a roundtable discussion with alumni of color. CALS welcomed three of these roundtable participants as new members to our board of visitors.

### **Critical Issue: Energy and Sustainability of Natural Resources**

In 2021, Extension and WEAS have continued to serve the people of Wisconsin at the crossroads of communities, natural resources and agriculture, helping individuals and communities to make informed decisions that support the state's rich land, water and mineral resources. Through our outreach efforts, we have made over 31,000 educational contacts. In 2021, a key research focus was set on water quality, and on protecting Wisconsin's waterbodies, especially in the Wisconsin Central Sands. One research project worked towards quantifying groundwater savings, yield potential, and water use efficiency improvements. The project also explored how accurate is the Wisconsin Irrigation Scheduling Program (WISP). They found that using WISP, there was a reduction in total irrigation application and using WISP over intuition to guide irrigation on field corn may result in larger water savings compared to other crops.

We are nearing completion of the first statewide map of surficial geology in Wisconsin. This map will be used for regional geologic studies, statewide evaluation and will help ensure that local decision-making (such as zoning or resource extraction) ensure protection of Wisconsin's water. In addition, we have conducted research on manure management and handling in 2021. Based on the results, we have developed best practices and training for Wisconsin's manure transportation/application industry, which will reduce the likelihood of accidental ground and surface water contamination throughout the state.

Throughout 2021, our outreach specialists, educators, researchers, affiliates and support teams have navigated complex issues related to water quality, have facilitated challenging conversations and have helped prepare and guide the next generation of community leaders. In 2021, we trained over 500 farmers, agricultural professionals, and agency staff on proper manure management. In addition, we have educated and supported close to 400 Water Action Volunteers, who contributed over 4500 hours monitoring the water quality in over 600 streams in Wisconsin. We continued to support close to 500 Master Naturalist Volunteers in serving stewardship, citizen science, and education efforts in Wisconsin, and we have hosted the St. Louis River Summit, a multi-state conference that brings together natural resource managers, scientists, educators and students who work on the St. Louis River estuary. Through the event, we have strengthened their communication and critical collaborations, improving the efficiency of public agencies and institutions as they work together to protect the dynamic estuary ecosystem at the headwaters of the Great Lakes.

One additional project/impact that is not in NRS is highlighted below:

**Research project: Life cycle analysis of wastewater-derived fertilizer**

PI: Phillip Barak and K.G. Karthikeyan

Issue:

Municipal wastewater treatment plants remove nutrients such as nitrogen from water to reduce eutrophication of waterways and preserve drinking water quality. The treatment plants send some of the nutrients back to farms in the form of biosolids, low-analysis fertilizers with less than 30% total available nutrients. Within the last decade, there has been growing interest in the potential production of high-analysis fertilizers (those with more than 30% total available nutrients) from wastewater. Whether it makes sense to produce high-analysis fertilizers at treatment plants depends on the price of production associated with each recovery technology. Whether it makes sense environmentally depends on complex considerations, including total energy, fossil energy, greenhouse gases, and more. Researchers at the University of Wisconsin–Madison aimed to better understand various nutrient recovery processes with the goal of guiding wastewater treatment professionals and reducing the environmental impacts of both agricultural production and wastewater treatment by recovering wastewater nutrients for recycling into high-analysis fertilizers.

What has been done:

The aim of this project was to provide critical knowledge about the environmental impacts of emerging nutrient recovery technologies, comparing them to existing nutrient removal systems at wastewater treatment plants. Nitrification/denitrification and partial nitrification-anammox are two accepted nitrogen removal techniques for wastewater treatment plants. These processes require energy for aeration and can release greenhouse gases in the form of nitrous oxide. Electrodialysis could potentially be used as an alternative to remove ammonium from waste streams. Using literature reviews, databases and life cycle assessment tools, scientists determined the environmental impacts of these nitrogen nutrient recovery methods. The environmental impacts they measured included power consumption, non-renewable resources consumption, global warming potential and more.

Impact:

From this work, the researchers found that nitrogen removal and recovery by electrodialysis is estimated to carry both lower initial capital costs and lower operational costs than traditional technologies at municipal treatment plants. Electrodialysis was also, by far, the preferable environmental choice of nitrogen removal technologies, projecting net negative impacts in key categories including greenhouse gas emissions and fossil fuel depletion. A second round of Hatch funding (beginning fall of 2022) will pursue second-generation improvements in electrodialysis technology for this purpose. Researchers aim to complete a similar analysis of phosphorus recovery technologies, and this work is still in progress using alternative funding sources.

Researchers shared their findings through two presentations at the American Center for Life Cycle Assessment (ACLCA) Conference and two peer-reviewed journal articles. One graduate student was trained on this project, and a research specialist and undergraduate student also gained experience through the work.

WAES and Extension provide research-based education and assistance with the goal of improving food security by increasing access to healthy foods for vulnerable populations and those in need; responding to growing consumer demands for sustainably produced local foods, including strengthening local food markets and systems; and promoting healthy diets. Research also focuses on ways to understand and reduce food-borne illnesses, while developing and disseminating new technologies to improve food safety. WAES has about 35 research projects handling these issues. Two impacts (projects are not in NRS) are highlighted below.

**Research project title: Engineering for food safety and quality**

PI: Richard Hartel and Scott Rankin

Issue:

In a nation where 71% of adults are considered overweight or obese, the U.S. food industry has long focused on developing food products that can help consumers reach their weight and health goals. A growing trend in the industry is to incorporate air into food products, in the hopes that consumers will take in fewer calories during a meal—yet still feel satiated. This is a promising approach to apply to frozen dairy desserts, such as ice cream, as it could lead to healthier products that have lower calories, lower fat and higher protein compared to traditional products. If done well, high-overrun frozen dairy desserts—those with higher levels of air in them—could benefit consumers as well as the frozen dairy dessert industry.

What has been done:

A research team at the University of Wisconsin–Madison has been exploring the parameters needed to manufacture tasty, high-overrun ice cream. Using a standard ice cream freezer, similar to those used by frozen dessert manufacturers, the researchers made batches of ice cream with overrun from 100% to 175% using a standard ice cream mix. They then assessed each batch for various structural properties (air cell size, ice crystal size, fat globule size), melting properties, sensory characteristics, and shelf life. Among other findings, they found that frozen desserts manufactured with higher overrun had better shape retention after melting at ambient conditions.

Impact:

These studies provide technical insights into the role of air in ice cream and frozen desserts and its influence on product texture. The data can be used by frozen dessert manufacturers to develop tasty frozen dairy desserts with higher air content, including low-calorie, low-fat and/or high-protein options. The lead researchers, one of whom is an Extension food science specialist, shared the findings with national and international ice cream manufacturers, ingredient suppliers and the broader food industry through a series of conference presentations and two published research articles. This project helped support the graduate training of one Ph.D. student and helped secure additional grant funding to continue the work from the National Dairy Council/Dairy Management Inc. and Wisconsin's state-funded Dairy Innovation Hub initiative.

Research/Extension highlight-

**Project title: EFNEP Related Research, Program Evaluation and Outreach**

PI: Beth Olson

Issue:

The first year of a baby's life is a critical time for launching a life-long healthy relationship with food. But it's also a difficult time for new mothers — especially those with limited income — to manage the needs of their new baby along with those of the rest of their family. This can lead to poor feeding practices and excess weight during infancy as well as unhealthy eating patterns and weight problems in the toddler years and childhood. The patterns often continue into adulthood and lead to chronic conditions, such as cardiovascular disease, diabetes, and certain cancers. Infant feeding education, such as that provided by the federally funded Expanded Food and Nutrition Education Program (EFNEP), can help establish good feeding practices at the outset and help families avoid long-term complications. Although a tool for measuring the effectiveness of this program has been developed, it is not appropriate for measuring impact specifically among low-income families.

What has been done:

The objective of this project was to develop a valid and reliable tool, called the Infant Feeding Education Questionnaire (IFEQ), to measure the impact of EFNEP infant-feeding education among low-income mothers with infants across the United States. The researchers created a list of infant-feeding topics and questions (based on existing curricula and materials used in EFNEP) and modified the topics and questions following a review by nine content experts. Three qualitatively trained researchers then conducted an initial test (cognitive interview) of IFEQ with carefully selected representatives of the target audience (recruited by UW Extension agents in Kenosha, Portage, Racine, and Sauk counties) to assess the cultural appropriateness and performance of each question. Revisions were made based on this assessment. Next, they tested the “construct validity” of IFEQ by comparing scores between two different groups (high knowledge/experience and low knowledge/experience) and then the “convergent validity” by comparing a group’s IFEQ scores with their scores on an infant care survey already used by the Centers for Disease Control. Mothers who participated in the convergent validity test also participated in a test-retest process to gauge the reliability of IFEQ over time. Based on findings, subsequent changes were made to the included questions, and more questions were added.

#### Impacts:

The researchers successfully developed a simple, culturally appropriate tool with easily understood questions suitable for a low-literacy audience that can be used to effectively evaluate EFNEP and similar programs. It demonstrated construct validity and reliability over time. Researchers presented this work in the February 2020 issue of the peer-reviewed *Journal of Nutrition Education and Behavior*, in which they identified areas for further work, including additional evaluation of convergent validity and the translation of questions into other languages used by EFNEP clientele. The questions were subsequently translated into Spanish. The completed IFEQ was presented to USDA National Institute of Food and Agriculture (NIFA) leadership and included in the Web-based Nutrition Education Evaluation and Reporting System (WebNEERS). It was also presented to EFNEP educators in March 2021 following their yearly meeting, the USDA Expanded Food and Nutrition Education Program Annual Conference, to make them aware of the development background of the questionnaire and its availability in WebNEERS.

#### Critical Issue: Human Development and Relationships

In 2021, our Extension educators and researchers had more than 160,000 educational contacts with people across Wisconsin on issues of parenting, financial literacy, aging, healthy eating, and other family-related topics. We made significant impacts in the following areas:

**Improving the health of older adults:** Wisconsin’s older adult population is growing more rapidly than other age groups, and a disproportionate share of aging population growth is in rural areas. In response, Extension is extensively working with older adults, their families and social services organizations. One of our flagship efforts is the implementation of the Aging Mastery Program (AMP) in 37 Wisconsin counties. AMP is an evidence-informed enrichment program developed by the National Council on Aging. Each Aging Mastery Program series entails 10 hours of education, including five to 10 weeks covering physical activity, healthy eating, social connectedness, advance care planning, community engagement, and healthy relationships. One hundred percent of surveyed participants were able to identify at least one change they made toward better health and well-being due to the program. Ninety percent said that the program helped improve personal finances. Ninety-six percent of participants said AMP helped with physical health; the same amount reported that it helped with their emotional well-being.

**Boosting financial skills for social workers:** One in three Wisconsinites is struggling to afford necessities such as housing, food, clothing, and transportation. Across our state close to 600,000 people live below the federal poverty level, and an additional 1.3 million Wisconsinites live in a household that struggles to cover basic household expenses. Many individuals and families turn to social service agencies for public assistance and other forms of support. In response, Extension developed and delivered a variety of training programs for professionals who address poverty in their work. The recently created Encouraging Financial Conversations (EFC) program is a six-session course providing those in helping professions with tools and resources to coach their clients on financial problem solving, goal setting, spending plans, saving, building credit and managing debt, maximizing income, and protecting themselves from scams, fraud, and identity theft. Through the EFC course participants showed statistically significant improvements across several outcome areas. They felt more comfortable working with clients on financial matters; they were more prepared to bring up a financial topic with their clients, and they understood the role they can take in working with clients on financial concerns. About one third of surveyed participants reported that they spend more time working with clients on financial topics than they were before the course.

**Supporting caregivers and caregiver relationships:** As people in our communities age, their family, friends, and neighbors take on caregiver roles with little to no compensation or support. Nationwide, over 48 million people provided unpaid care to a person over the age of 50 in the last year; 578,000 of those family caregivers are in Wisconsin. Extension responds by providing caregivers with evidence- and research-based information on self-care techniques; connecting them to local resources including other caregivers within the

community for support; and increasing caregiver confidence and decreasing stigma around accessing resources. Extension engages with caregivers through monthly caregiver support meetings or by request from local partnering agencies. We lead education on building resiliency, managing grief, finding joy, utilizing self-care techniques, making end-of-life decisions, and building financial health. In addition, Extension offers parenting seminars to caregivers to help them develop supportive relationships with their children. In 2021, Extension led 35 caregiver programs across the state. Surveyed participants in programs reported better self care; 85% of participants identified one or more new ways to take care of themselves through the program and over 60% said that they practice self-care more often or regularly than before.

**Positive Coping Strategies to Reduce Stress amongst youth and adults.** While the pandemic had a substantial impact on all Americans, for some the impact has been more negative than others. Parents faced the increased stress of school and child care cancellations. Essential workers faced the fear of infection while working. Low-income workers faced economic insecurity due to layoffs and reduced hours. Young adults and adolescents struggled with virtual schooling, the loss of social connections, and disrupted future plans. Extension responds by teaching a variety of stress management techniques and mindfulness to adults, adolescents and those in helping professions. Our flagship courses “WeCOPE,” “Highlights of Taking Care of You,” and “Learning to BREATHE” taught skills that increase positive emotion, helped participants to recognize emotions, and helped them develop healthy coping skills for dealing with stress. In 2021, we held 68 workshops and educational series based on these courses with over 2600 educational contacts. Eighty nine percent of surveyed “WeCOPE” participants reported that the skills they learned during the program helped them cope with stress. Youth who participated in the Learning to BREATHE series indicated that the program had given them new tools to help them cope with stress. After the program, 62% said that they could cope with stress well or very well; before the intervention, this was the case for only 28% of youth.

**Critical Issue: Positive Youth Development**

In 2021, Wisconsin’s Extension Positive Youth Development educators made over 16,500 educational contacts with adults and over 35,500 educational contacts with youth. In addition, over 22,000 youth participated in more than 900 4-H clubs and groups in 71 Wisconsin counties where they benefited from the support of over 7,000 4-H volunteers. These clubs offer experiential learning opportunities, including over 100 distinct individual project activities led by adult volunteers and older youth using 4-H curriculum, group projects including service-learning, and opportunities for youth leadership through teaching others, planning club activities, and making organizational decisions in partnership with adults. Youth members also participated in-person and virtually in county-wide regional and statewide learning and community-building opportunities to build on their club and group experiences. These programs are designed to provide the opportunities for youth to develop and explore interests in a safe environment, develop supportive relationships with peers and caring adults, and to experience scaffolded opportunities for leadership. Age-appropriate developmental pathways are available within multi-age programs and across programs offered at the club, county, regional, state, and national level.

Our 2021 WI 4-H Youth Thriving Survey, a nationally validated measure, was completed by 2647 of 10,744 4-H members aged 12-19 (25% response rate). The results showed that 4-H participation results in the desired outcomes for youth. The data showed that a positive 4-H experience was a statistically significant predictor of positive youth development outcomes, regardless of other socio-demographic factors. In simple terms, Wisconsin 4-H is offering high quality experiences for youth that result in positive youth development outcomes for any youth who participates. The evaluation demonstrated that the large majority of 4-H clubs and groups provided high quality youth development experiences. 4-H youth demonstrated behaviors linked to positive developmental outcomes such as demonstrating a growth mindset and a prosocial orientation. Overall, Wisconsin 4-H members demonstrated strong academic, social-emotional, and civic outcomes.

Wisconsin’s Community Youth Development programs engaged youth leaders and built community capacity to address a broad range of community issues. Youth and adults partnered to use the Youth Advocates of Community Health process to address health issues, including addressing mental health stigma, and creating safe places to walk and exercise. Extension staff supported Raise Your Voice youth clubs to support youth leadership in mental health. 53 youth served in advisory roles on local government boards alongside elected officials in eight counties, with intensive training and support from Extension educators. Extension educators also support 29 Teen Court programs in Wisconsin, so youth facing disciplinary action can work with peers to restore their relationship with the community. Extension led a Restorative Justice Summit, where over 530 participants, including human service professionals, Teen Court facilitators and youth panelists, K-12 staff, elected officials, and law enforcement, built knowledge about utilizing restorative approaches when working with youth.

**Critical Issue: Sustainable Ag Systems and Production**

In 2021, our Extension Agriculture educators and researchers have made over 220,000 educational contacts with agriculture professionals (farm managers, farm workers, industry consultants), home gardeners, and the general public to support the production of safe food, minimize the impacts of horticultural and agricultural management on the environment, and to improve the economic sustainability of

agriculture and horticulture industries. Our 2021 response has focused on alleviating the converging pressures brought on by ongoing climate change and the COVID-19 pandemic.

Extension heavily supported farmers in managing a variety of disruptions (financial, workforce-related, supply-chain related, and related to mental health and stress) by empowering them to explore new directions and opportunities, and by helping them assess and plan for new business strategies. We created resources and held education events to increase producer understanding of costs of production, pricing products, estimation of future costs and risk assessment. In 2021, this included information on support programs such as the CARES Act Paycheck Protection and Economic Injury Disaster Loan Programs. Our educators additionally focused on supporting Wisconsin farmers in exploring new markets, (such as hazelnuts, hemp, hops, etc.). While in-person and virtual education remained at the core of our mission, our online resources related to farm management were viewed over 167,000 times in 2021.

Climate change has challenged the production of traditional forages, depleting feed storage for dairy producers, and driving up prices for feed. Consequently, Wisconsin farmers explored growing alternative forages for dairy cattle. Additionally, milk supply chain issues related to the COVID pandemic led dairy producers to reduce their number of milk cows by breeding their young stock to beef breeds. To ensure that these changes are economically and environmentally sustainable, farmers needed fact-based information and decision tools. In response, our 2021 research and educational outreach focused on assessing the economic and nutritional feasibility of alternative cover crops for producers, and on better understanding the growth and performance of crossbred cattle.

Progress was also made on the breeding progress with potatoes. Genomic selection combines historical data with genome-wide markers to predict the breeding value of new germplasm more quickly, which enables reducing the time to parent selection. This reduction is generally considered the most effective way to accelerate genetic improvement for crops and livestock. Genomic prediction models for total yield, vine maturity, specific gravity, and chip color, based on data from 6 years and over 900 genotypes, were made publicly available through the R software package StageWise. These data and models were used to shorten the University of Wisconsin breeding cycle, from the traditional 6-8 years down to 4 years. Outreach to the wider breeding community has contributed to improved knowledge about using genomic selection for many different crops.

The pandemic has also impacted home gardeners in Wisconsin: Due to food insecurity, stay-at-home orders and fear over disease transmission, many Wisconsinites sought alternative ways to learn about home horticulture and gardening. In response, we developed a new Horticulture course that taught over 500 home gardeners research-based methods in growing plants and managing pests. This self-paced online course included embedded video presentations and interactive learning activities and live question-and-answer webinars with subject matter experts. In addition, Wisconsinites received environmentally friendly advice based on sending Extension samples of insects and plant disease, which were tested in diagnostic labs. In 2021, an estimated 20,000 Wisconsinites obtained individualized plant care solutions by getting their gardening questions answered through a county office, through the Extension statewide diagnostics inquiry system, or through a diagnostic lab.

Progress was made on improved models of pollinator abundance that operate at the field-scale. Food for bees comes from the flowers they forage on for pollen, their primary protein and lipid sources, and nectar for carbohydrates. Therefore, to fully understand what specifically about habitat loss or habitat modification affects bees requires that we explore the relationship between the landscape, flowering plants, and bees. This project has shown that flower availability in agricultural landscapes is a dominant driver of bumble bee abundance, occurrence, and colony-level fitness. See detailed impact report below-project is not in NRS.

**Project title: Modeling wild bee occurrence in Wisconsin agriculture** (project ended in 2021)

PI: Claudio Gratton

Issue:

Insect declines, and pollinators more specifically, have recently been poster children of a biodiversity crisis given the direct link between insect pollinators and the provisioning of food for people. A combination of factors such as habitat loss, pesticide use, and the spread of exotic pathogens are significant contributors to wild and managed bee declines. Habitat loss for bees, the most diverse and most important pollinators for wild and crop plants, means the loss of food and shelter. Bees depend on flowering plants — pollen for protein and nectar for carbohydrates. In the Midwestern U.S., farms grow a relatively small variety of crops and fields are large and contiguous. For bees, this means fewer desirable flowers in the landscape. If pollen resources are available, they are present only during brief periods. Researchers at the University of Wisconsin–Madison wanted to explore the relationship between the landscape, flowering plants, and bees, using both experimental and observational approaches in Wisconsin’s agricultural landscapes.

What has been done:

Researchers examined how variations in flowering resources influenced bumble bees using field, laboratory and modeling approaches. With tags mounted on the backs of bumble bees, they studied how bees respond to pulses of flowers, such as when a mass flowering crop comes into bloom. Working in Wisconsin cranberries before, during and after the crop bloom period, they found that bumble bees are highly responsive to the onset of cranberry bloom. During cranberry bloom, bees were highly attracted and foraged within this mass flowering crops, showing that they could adapt behaviorally to fluctuating food in the landscape. Field studies also showed that attraction to highly abundant flowering resources led to greater reproductive success, but bees could withstand periods of low food availability. In lab studies, scientists found that the total quantity of food mattered most, not the consistency of food availability. Finally, researchers used datasets on the historical patterns of agriculture extent and cropland diversity to explore the question of how agriculture influences bumble bees. Through modeling, they found that there was a strong association between lower crop diversity within a county and bee declines. Agricultural landscapes with a higher diversity of crops are better environments for bees than those that are dominated by a few crops.

Impact:

This project found that flower availability in agricultural landscapes is a dominant driver of bumble bee abundance, occurrence and fitness. High diversity of crops in agricultural landscapes appears to benefit all bumble bees. These findings offer opportunities for improving bee habitat at a variety of scales. At the farm-scale, flower plantings can increase colony performance, while at the landscape-scale, high diversity of crops increases the likelihood of bumble bee occurrence. Agricultural production is not necessarily bad for pollinators such as bumble bees, as long as cropping diversity can be maintained.

This work was shared with entomologists and ecologists, as well as the communities of Wisconsin, via a public PhD defense presentation and a Wisconsin bumble bee website (<http://pollinators.wisc.edu>). A graduate student was trained on this project, and several undergraduates also participated in the study. Five scientific journal articles were prepared (four in press) from this project, and research presentations were given at various academic and professional society meetings.

#### **Critical Issue: Sustainable Use of Natural Resources**

@NIFA reviewer: This critical issue is an obsolete critical issue that should be deleted from the system. It has been replaced by the approved critical issue "Energy and Sustainability of Natural Resources" (above). The research projects tagged to this critical issue have been updated.

#### **Critical Issue: Urban and Rural Community Vitality**

WAES has several new and exciting research projects that are working on several urban issues to assist the agricultural community. One impact to highlight is about ag-automation hazards and developing a risk reduction model. A simple model was developed that would draw from PAST incidents and conditions creating scenarios and realistic events (based on past data) that engineers can use in their design and risk assessment processes. This operational scenario generator was created using the historic fatality records to provide statistically based hazard generation. Its operational scenario generator provides evidence that historical data can be used to augment the efficacy of existing risk assessment tools. Another project is highlighted below (project is not in NRS):

#### **Title: Economics of Identity in Agriculture**

PI: Paul Dower

Issue:

Evidence is growing across the field of economics that aspects of individuals' identity, including race, affect economic outcomes. In the early twentieth century, the percentage of all American farm owners who were Black peaked at about 14 percent (higher than the Black population share). A century later, Black farm operators now account for less than two percent of American farmers (despite growth in the Black population share). This trend is even more exaggerated in the Midwest, particularly in Wisconsin with only 42 Black principal farm operators out of almost 70,000 total in 2012. While most professions (and the United States population) are becoming more diverse, farming is not. In recent years, numerous journalistic publications and rural sociologists have documented the dramatic decline of Black farming through stories of these farmers' struggles with lending and loss of land ownership. There remains a need to better examine and understand this trend and its impacts through an agricultural economics lens.



What has been done:

Researchers at the University of Wisconsin–Madison gathered and analyzed large amounts of data from agricultural schedules of the U.S. Census and the USDA's Census of Agriculture. This was challenging due to inconsistencies in how data were recorded and gaps in the data (due to records destruction and a 72-year hold on the release of personally identifying census data). The researchers found that in the Midwest, counties with Black farmers in 1870 were much more likely to have Black farmers in 1940. The opposite was also true: Counties with no Black farmers in 1870 were much less likely to have Black farmers in 1940. These effects were stronger in the Midwest than in the South, and much stronger than in the Northeast. Moreover, these patterns were found to be specific to farming and did not hold for the general Black population. In Midwestern counties with Black farmers in 1870, the share of Black people choosing farming as an occupation in 1940 converged with the share of whites choosing farming. There was no such pattern in the Northeast. From 1940 to 2012, shares of Black farmers declined dramatically, reversing this regional pattern. The researchers also found that 2012 per capita farm revenue was about 10 percent lower in counties with a historical presence of Black farmers.

Impacts:

This project has resulted in an increased understanding of the racial patterns of farming in the United States and prompts several additional questions for future research. The findings are striking because they are at odds with what economists have broadly observed in the wakes of the Great Migration and World War II: a new mobility for women and non-white workers who became redistributed into most industries and geographical areas. That redistribution of talent has been beneficial to economic growth. This research, however, confirms the farming sector is an outlier. More research can be done to determine factors influencing this pattern. This project has provided training and professional development for three PhD students who worked with large historical datasets and geographic information systems (GIS). It resulted in a research paper currently in development and various conference or symposium presentations.

Extension works with communities across Wisconsin to support individuals, groups, and organizations to fulfill their desire to enhance quality of life and improve overall well-being for members of their community. We support efforts that promote resilient, sustainable and ultimately thriving communities for people today and the generation to come tomorrow and beyond. In 2021, Extension provided research, consulting, and educational programs to more than 31,000 educational contacts.

Through our programs focused on Organizational & Leadership Development and Local Government Education, we have successfully supported Wisconsinites in taking on new leadership roles in communities and local governments, and in building their capacity to serve the people of Wisconsin. For example, we served over 2400 local government officials and their staff in 560 municipalities on how to conduct mandatory Board of Review processes. Additionally, over 480 participants in our leadership development programs reported that they have taken on new leaderships and opportunities due to Extension programming.

Through our 2021 education, we have helped communities and organizations plan and thrive. For example, 75+ community or organizational plans and policies have been developed with our support across several initiatives, and 65+ have been adopted or implemented. Extension helped local governments and communities in saving over 140,000 USD through helping them establish operational and strategic efficiencies. Additionally, participating organizations and communities leveraged over 9 million dollars in grants and resources to address critical issues (such as affordable housing and broadband infrastructure) based on our educational programming and support.

**Critical Issue: Wisconsin Competitive Program**

This critical issue is not in use.

## **Merit and Scientific Peer Review Processes**

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**Updates**

**Merit Review.** The merit review process for WAES consists of a combined external and internal university panel. A 10-person faculty Research Advisory Committee (RAC), appointed by the CALS Associate Director of the Agricultural Experiment Station was increased to a 12- person committee. Since CALS has 16 academic departments, increasing the membership allows for a more equal distribution of the number of proposals to the reviewers.

**Extension:** No Updates.

**Scientific Peer Review Process.** No updates (WAES & Extension)

## Stakeholder Input

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

**WAES:** Because of public health guidelines to restrict the spread of COVID-19, many of our events and discussions were held virtually again this year, with many more recently returning to in person. In some cases, we saw greater levels of participation because virtual meetings require less travel and are easier to schedule, but difficulties accessing broadband reduced the ability for some to participate through these formats. We met with the following groups to gain insights on current trends and needs:

- UW Center for Cooperatives Advisory Board
- Integrated Pest and Crop Management Advisory Committee
- Wisconsin Potato and Vegetable Growers Association
- Wisconsin Cranberry Growers Association
- Professional Dairy Producers of Wisconsin
- The Wisconsin Corn and Soybean Growers
- UW Agricultural Nitrate Working Group
- Midwest Rural Energy Council Board of Directors
- Center for Integrated Agricultural Systems Citizen Advisory Council
- Food Research Institute Corporate Affiliates
- Center for Dairy Research Industry Affiliates
- Wisconsin Department of Agriculture, Trade, and Consumer Protection
- Wisconsin Farm Bureau Federation
- Wisconsin Farmers Union
- UW Organic Collaborative
- Grassland 2.0 external advisory committee
- Dairy Innovation Hub statewide steering committee

**Extension:** No updates.

### Methods to identify individuals and groups and brief explanation

**WAES:** Faculty, staff and administrative leaders in the college maintain close relationships with industry leaders and agricultural advocacy groups.

- The dean and other leaders meet quarterly with the two largest farmer groups in Wisconsin: the Wisconsin Farm Bureau Federation and the Wisconsin Farmer's Union.
- Programs in the college formed several new advisory groups this year to diversify perspectives:
  - Processors in the state launched a meat industry coalition, with technical participation from the state department of agriculture and researchers in CALS.
  - An institution-wide initiative to strengthen partnerships with Native Nations has grown to include active research and extension collaborations with faculty and staff.

**Extension:** no updates.

### Methods for collecting stakeholder input and brief explanation

**WAES:** This year, most of our largest educational events were held in a hybrid format, we were able to attract new attendees and gather questions and input from elected officials, new farmers, long-time bankers and food consumers. Here are some of our largest public events:

- Dairy Summit (100% virtual)
- Dairy Symposium (hybrid)
- Agricultural Outlook Forum (hybrid)

**WAES:** Our field days held at agricultural research stations, returned in person in the 2021 growing season. Schedule of field days:

- Arlington Agronomy/Soils Field Day
- Arlington UW Organic Agriculture Research Field Day

- Hancock Potato Research Field Day
- Hancock Garden Tour
- Kemp Diseased, Decayed and Dangerous: When Good Trees Go Bad
- Kemp Fungi Festival
- OJ Noer Wisconsin Turfgrass Association Summer Field Day
- West Madison Vineyard Walk

**Extension:** No updates.

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

**WAES:** Public input informs choices at all levels of the college.

- The Seed to Kitchen project taps both chefs and vegetable farmers to provide input on new varieties of sweet corn, tomatoes, beets, carrots and other vegetables developed by a number of individual faculty. The chefs and farmers inform both which vegetables can be improved, and which characteristics are most desirable.
- Through the Dairy Innovation Hub, CALS has hired four faculty positions of greatest interest to the industry. The Hub's Steering Committee has prioritized an additional two searches for recruiting in 2022.
- Agricultural stakeholders and Wisconsin legislators identified three faculty positions to fill with newly appropriated state funds. These include a forage systems agroecologist, facility and environmental control engineer and a precision pest ecologist. We expect the searches to be completed in 2022.
- Finally, the college is in the early stages of a facility master plan process and expects to gather input from a number of stakeholders on facility priorities beginning in 2022.

**Extension:** No updates.

## Highlighted Results by Project or Program

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Type	Projects / Programs
<b>Projects / Programs without a Critical Issue</b>	<b>2</b>

### [Development of \*Lactobacillus reuteri\* as an Antimicrobial Delivery Vehicle](#)

Project Director

Jan Peter van Pijkeren

Organization

University of Wisconsin Madison

Accession Number

1020048



### **Development of *Lactobacillus reuteri* as an Antimicrobial Delivery Vehicle**

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

Microbial antibiotic resistance is a global problem. To continue to treat microbial infections in an agricultural setting or in the clinic, novel antimicrobial therapeutics are essential. Our project aims to engineer a probiotic bacterium to secrete antimicrobial peptides to kill microbial pathogens, including the foodborne pathogen *Listeria monocytogenes*.

**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.**

First, we implemented an approach to release antimicrobials that does not require a signal peptide. Here, we rely on the activation of normally dormant bacterial viruses that lyse the engineered probiotic during gastrointestinal transit. During this reporting period, we have leveraged that to secrete recombinant proteins from *L. reuteri*. This has proven successful in various preclinical disease models. Using this approach, in collaboration with the Elfenbein lab (Dept of Pathobiological Science) at

the UW-Madison, we engineered the probiotic to release an antimicrobial peptide to target *Salmonella*. The preliminary findings demonstrate that the antimicrobial peptide released by our engineered probiotic does significantly reduce *Salmonella* viability *in vitro*. These data are now leveraged as preliminary data for a NIH R21 application, and the revised application is submitted this month.

Under this current project, we are further developing *L. reuteri* as a therapeutic delivery vehicle. Efficacy of therapeutic release directly controlled by the efficacy of lysis. To control lysis, we have discovered an antirepressor gene that upon expression efficiently activates the native prophages leading to lysis. To compare, induction by the chemical reagent mitomycin C—the universally used inducer of prophages in bacteria—yields less lysis and phage particles compared to induced expression of the antirepressor. This is a significant finding because controlling lysis means controlling therapeutic release, which opens up previously unexplored opportunities to identify promoters that are activated in the presence of a pathogen, for example, that will lead to activation of the antirepressor and thus therapeutic release. We have functionally characterized the antirepressor and an invention disclosure has been accepted by WARF.

Lastly, in our quest to develop novel antimicrobials, we identified a novel secondary metabolite produced by *L. reuteri* that has strong antimicrobial activity against strains of the same species. This work is *accepted in principle* by the journal Cell Host & Microbe.

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

Our project will be of interest to a broad audience since we focus on the development of antimicrobial strategies independent of antibiotics. Strategies to reduce the application of antibiotics will also be of interest to other farmers, including poultry and cattle (dairy and meat). Also, our target audience will be scientists from the public sector, private and academic, which includes—but is not limited to—students, staff scientists, postdoctoral trainees, and faculty.

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

Aside individuals in agriculture, the progress we made towards the development of a probiotic producing an antimicrobial is of relevance to anyone receiving healthcare to treat bacterial infections. If successful, our approach will provide novel opportunities to treat bacterial infections that have developed resistance to conventional antibiotics.

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

Other than lost productivity due to the pandemic, we did not encounter major technical problems. We have been very grateful for this support that placed us in the position to train students, to produce key data for a grant application (NIH R21), to garnish interest from WARF on one of our invention disclosures (which was made possible through the Hatch award), and we have generated a high-impact publication in Cell Host & Microbe (impact factor 21). Several co-authors on the Cell Host & Microbe have received prior Hatch support. In addition to the continuous development of our probiotic to produce recombinant antimicrobials, we plan to test the antimicrobial activity of the secondary metabolite against pathogens.

**[Food Insecurity in Wisconsin](#)**

Project Director

Judith Bartfeld

Organization

University of Wisconsin Madison

Accession Number

1020164



**Food Insecurity in Wisconsin**

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

Whereas annual data collected via the Current Population Survey – Food Security Supplement (CPS-FSS) provide robust national estimates of food insecurity, sample sizes limit the availability of food insecurity estimates at the state and especially substate level. The purpose of this project is to develop a flexible method to assess how food insecurity risk varies within states. Our goal is to develop and use this approach to increase understanding of food insecurity risk in Wisconsin, while also developing a method with broader applications beyond 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.**

Our major activities in 2021 involved extensive work developing and refining our methodology for estimating food insecurity risk, including expanding our focus from geographic substate variation to also include in-state variation among demographic subgroups. We focused on finetuning our CPS model; constructing a sample with an analogous universe from the much larger American Communities Survey (ACS); reviewing literature relative to our methodology; developing food insecurity risk estimates from the ACS; and benchmarking our results against a variety of metrics, including the Map the Meal Gap estimates. We also explored similarities and differences in food insecurity patterns prior to and during the pandemic, to assess the pros and cons of combining data from before and during the pandemic in our predictive models.

We submitted a proposal to present the methodological aspects of our work at the 2021 APPAM Conference. The proposal was accepted, though the conference was delayed due to the pandemic. We have completed a draft manuscript that will be presented at the rescheduled conference in March 2022.

We have been exploring a range of potential applications for using our Wisconsin-specific food insecurity analyses and risk estimates. These include state-level food security assessments informed by information on food insecurity risks within the state, in conjunction with partners in the Division of Extension; and use of in-state food insecurity information to inform expansion of emergency food outlets in the state. We are also exploring the integration of in-state food insecurity risk estimates into an existing online food security data and mapping portal. We will be sharing some aspects of our work at the upcoming Wisconsin Hunger and Health Summit.

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

We have used initial information from food security analyses in food security presentations for local/internal audiences. Because our work has thus far been primarily developmental and focused on finalizing our methodology and estimates, target audiences have not benefited substantially from our activities at this stage. Our final year is more focused on applications and dissemination.

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

Because our work has thus far been primarily developmental, the broader public has not yet benefited from our activities at this stage. Our final year is more focused on applications and dissemination.

**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 have not encountered any major problems in our approach. As noted, we have expanded our focus from geographic variation within states to also include demographic subgroups within states. This allows, for instance, a clearer understanding of disparities in food insecurity risk across race/ethnicity, disability, and other dimensions. As noted above, we have been exploring a range of potential applications for using our Wisconsin-specific food insecurity analyses and risk estimates.