

Alabama (Alabama A&M University, Auburn University, Tuskegee University Combined) Annual Report - FY2022

Report Status: Approved as of 05/08/2023

Contributing Organizations

Alabama A&M University
Auburn University
Tuskegee University

Executive Summary

Overview

Alabama is unique as being the only state with three land-grant institutions with United States Department of Agriculture (USDA) Research and Cooperative Extension responsibilities. Alabama Agricultural and Mechanical University (AAMU), Auburn University (AU), and Tuskegee University (TU) provide Research projects and Cooperative Extension programs that meet the needs of the citizens of Alabama and the nation.

AAMU is an 1890 land-grant institution with a comprehensive university Carnegie classification, functioning in the areas of teaching, research, and extension. Through dynamic and contemporary research projects and extension programs, the institution maintains a strong commitment to academic excellence and community engagement to meet the needs of its students, communities statewide, and nation at-large.

AU is an 1862 land-grant institution with high research activity; comprehensive doctoral university Carnegie Research 1 classification. AU's mission is defined by its land-grant mission. AU serves the citizens of Alabama through its instructional, research and extension programs and prepares Alabamians to respond successfully to the challenges of a global economy.

The TU mission, historically and today, together with specific acts of the United States Congress and the state of Alabama defines Tuskegee as an 1890 land-grant university with a Master's College and Universities Carnegie classification. Through integrative teaching/learning, research/discovery, and Extension/engagement programs TU addresses contemporary societal problems as opportunities to advance individuals, families, and communities.

Research at each Alabama land-grant institution (LGI) has distinct projects based on clientele needs. Each component of the Alabama Agricultural Research Program works closely and cooperatively to enhance partnerships among the universities in all areas of Research and Extension; with other universities in the region, nationally, and internationally; and with state and federal laboratories and agencies. Alabama's three land-grant universities have played key roles in the development of agricultural enterprises in Alabama. The agricultural research programs of these universities have formed a partnership, the Alabama Agricultural Land-Grant Alliance (AALGA), to better address critical issues in food, agriculture, biosecurity, data science, rural sustainability, environment, bioenergy, and natural resources in the state, region, and nation through multidisciplinary, multi-institutional, science-based teams that focus on the opportunities and the challenges facing farmers, consumers, and agribusinesses. AALGA also seeks to provide quality education that prepares professionals for career opportunities in food, agriculture, environment, and natural resources. Research projects at each of our institutions are closely linked to Extension programs, which seek the largest possible positive social, economic, and environmental impact.

AAMU and AU provide Extension educational outreach as a unified Alabama Cooperative Extension System (ACES). ACES focuses its resources on relevant issues that affect the interdependence of urban, suburban, exurban and rural clientele. ACES employs a highly collaborative program development and delivery process that allows for the integrative and collaborative application to serve and meet the needs of Alabamians in all 67 counties within the state. Agents from the two institutions are jointly located in county Extension offices and function as county Extension teams.

Tuskegee University Cooperative Extension Program (TUCEP), in partnership with the Evans Allen Research Program, Carver Integrative Sustainability Center (USDA 1890 Center of Excellence) and other research, teaching and outreach units, carries out a comprehensive Extension Plan of Work (POW). TUCEP continues to focus its major efforts in the Alabama Black Belt and adjacent counties, but also has programs in other counties whose residents may request our expertise and/or experience. Many TUCEP agents share the same facility as ACES agents assigned to that county and cooperate on Extension programs of mutual interest.

The world and our state are facing major challenges with population shifts, food, water, energy, agricultural and environmental sustainability, rural prosperity and resilience, biosecurity, natural resources, climate change, and economic development in all sectors, as well as human health and well-being and related issues. In order to address issues related to these major local, national and international challenges, integrative and collaborative Research projects and Extension programs have been designed to address most of these challenges. The Alabama Land-Grant Institutions are cognizant of the necessity to continue to address the National Institute of Food and Agriculture (NIFA) priorities. Indeed, those priorities are priorities for Alabama residents as well.

Alabama's Extension and Research seek to address selected questions that lead to identification of critical issues of strategic importance. These issues include, but are not limited to: (1) enhancing the sustainability, competitiveness, biosecurity, and profitability of U.S. food and agricultural systems; (2) playing a global leadership role to ensure a safe, secure and abundant food supply for the U.S. and the world; (3) heightening environmental stewardship through the development of sustainable management practices (food/water); and adapting to and mitigating the impacts of climate change on food, feed, fiber, and fuel systems in the U.S.; (4) improving human health, nutrition, and wellbeing of the US population; (5) promoting community development, rural health, prosperity and resilience; (6) building capacity of individuals and families in the context of learning, culture, and community; and (7) supporting energy security and the development of the bio-economy from renewable natural resources in the U.S.

All planned projects and programs contained in the Alabama integrated Extension and Research FY2022-2026 Plan of Work were developed within the context of research and community engagement with relevance to all residents of Alabama who may benefit from the local knowledge base or service. This commitment is without regard to any personal characteristics, to include age, ethnic origin, gender, religion, sexual orientation, or geographic location. Alabama populations are included, as appropriate, in the project and program development process. As a part of the development process, each project or program that was identified and developed for grassroots program delivery, details the intended audience(s) to be served. As a part of the review process, the respective Assistant/Associate Directors and Administrators are charged with ensuring that the intended audience(s) for each project or program includes the spectrum of potential recipients of the Alabama population. For example, in recognition of the rapidly increasing Hispanic populations in Alabama, many of the System publications are now available in Spanish while other programs specifically target the Spanish speaking residents. Additionally, the ACES website provides educational content in 65 languages spoken throughout Alabama. To meet the accessibility needs of our audience, the website complies with Web Content Accessibility Guidelines 2.0 Levels A and AA and is mobile-friendly for use on smartphones. All video used on the website is captioned, and online courses are also fully accessible. Other System programs target 'at-risk' youth, low-income urban residents, small and minority farm producers, and the elderly.

All such projects and programs are Logic Model based and include clearly defined expectations regarding program outcomes and impacts. The necessity for--and inclusion of--outcome and impact statements for every funded Research project and Extension program offering is paramount in the planning and development process. As such, all projects and programs are inherently capable of producing quantifiable measures of research, education and extension productivity.

The ability to answer the question 'So What?' is a driving force in the planning, development, and delivery process. All levels of Research and Extension administration continually issue the challenge to ensure that expected outcomes and impacts are clearly evident in program design, and that continuous improvement is woven into plans-of-work.

Critical Issue: Community Development

Alabama's Community Development initiatives have assisted communities address challenges and opportunities concerning workforce development, entrepreneurship, tourism, leadership, broadband, and disaster preparedness. While Alabama's unemployment rate remains low at 2.5% (6th nationally/BLS), our labor participation rate remains below 57% (STLFED) which places the state in the bottom five nationally. Boosting workforce retention and participation are key fixtures of community development programming as Extensions offerings include youth career exploration and technical skills offerings promoting STEM concepts and entrepreneurship principles. For

adults, programs targeting unemployed or underemployed Alabamians increase resource awareness, knowledge concerning broadband access and usage, workplace skills, and soft skills trainings are key priorities. Additionally, programming serving employed individuals helps Alabamians remain employed and foster healthy workplace environments boosting retention.

Community development initiatives addressing broadband, leadership, and disaster preparedness are also growing. Expanding broadband access and digital literacy is a key ingredient to increasing Alabama's economic competitiveness and we are supporting the Alabama Department of Community Affairs share information to communities about how they can become more knowledgeable and engaged. With respect to disaster preparedness, Alabama is the fifth most likely state in the US to experience a natural disaster; consequently, ensuring Alabamians, and their leaders, are prepared to mitigate, prepare, respond, and recover successfully from emergencies and crises is vital to the health and wellbeing of Alabama communities. Projects underway include developing strategic plans with volunteer organizations active in disaster, creating disaster education videos for agricultural producers, and disseminating severe weather preparation information and distributing weather radios to vulnerable Alabamians in substandard housing.

Critical Issue: Family, Home, and 4-H and Youth Development

Alabama families continue to encounter numerous challenges related to health and well-being, youth engagement, the impacts of inflation, workforce readiness, and family relations. Extension offers 4-H youth development, family and child development, financial resource management, and workforce development programs that empower youth and adults to achieve in all circumstances. Emphasis has been placed on (a) helping youth thrive, (b) financial resource management, (d) mental health, (e) reducing isolation and promoting a sense of belonging, (f) skill development for employability, and (g) parent education. 4-H youth development programs also emphasize Science, Technology, Reading, Engineering, Agriculture, and Math (STREAM) Education.

Critical Issue: Food Systems and Food Safety

Integrated research and extension activities are ongoing to enhance food systems, food safety and agricultural biosecurity. Projects and programs strive to develop technology and methods to protect the safety of agriculture and food, to enhance food safety, reduce epidemics of food-borne illness, and to develop the knowledge and a methodologies base for rapid detection of threat agents, including existing and emerging diseases of plants and animals, risk assessment, and facility and personnel security. Targeted audiences include industry, government and consumers on how to avoid food-borne diseases; safe home food preservation; and educating food handlers and processors on how to ensure safe food products all along the food chain. Specific projects include production techniques and therapeutics for fish, beef cattle, and poultry production, as well as developing strategies for reducing food safety risks for fresh produce.

Critical Issue: Global Food Security and Hunger

The competitiveness and sustainability of food and agricultural industries are priorities of the land-grant partnership in Alabama. The ongoing focus is the development and implementation of best practices or technologies. Two broadly defined priority areas are: i) plant health and production and plant products, including improved cropping systems, plant breeding/genomics, integrated pest management, and alternative specialty crops and production systems; and ii) animal health and production and animal products, including improved food-animal systems and stocks, and alternatives to antibiotic use. Projects and programs include organic agriculture and local foods, agricultural economics, needs of limited resource producers, and limited-space production systems.

This critical issue focuses on the use of evidence-based best practices, to ensure that relevant scientific [\[Ma1\]](#) information addressing food and nutrition is accessible to all communities to insure the availability and security of food systems. The three land grant institutions in Alabama coordinate their research, and extension activities, and collaborate to provide information to local stakeholders in support of the adaptation of local knowledge for implementation. The information generated helps to identify and enhance the management of agricultural resources and food systems to expand access and participation by all stakeholders. Significant attention is given to increasing the availability and affordability of high-quality nutritious and safe foods while promoting access to develop business entrepreneurship related to agriculture and food systems.

Research with the use of modern and advanced technologies to understand, identify more resilient, and productive agricultural practices to restructure and sustain agricultural and food systems are the priorities of this critical issue. Stresses and changes relating to climate change, and their impact plants and animals with higher degrees of catastrophic outcomes must be addressed, and be replaced where conventional methods are no longer adequate to provide security for food and nutrition systems. Attention to educating communities on strategies for preparing for disasters, emergencies, and other impactful events to food and nutrition security, including biotic and abiotic stresses that adversely impact the agricultural sector are among the work carried out by the land grant institutions in Alabama. The impact is to reduce, hunger, and increase resilience for global food security.

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Critical Issue: Human Nutrition, Well-being, Health and Obesity

Individuals and families in the state of Alabama continue to struggle with the ability to manage their nutrition, physical activity, and other strategies to maintain proper health. The challenges are compounded by health disparities/inequities, limited access to healthcare, and a lack of affordable resources to prevent or self-manage chronic conditions. Extension offers human nutrition, diet, and health programs to address these issues by providing resources and educating individuals and families to make better health decisions. We continue to seek innovative solutions to improve individual, family, and community health outcomes statewide.

Critical Issue: Natural Resource and Environmental Sustainability

Agricultural and natural system sustainability is critical in the context of climate change. Ongoing efforts focus on facilitating natural resource management in relation to: sustainable agricultural systems, energy conservation and utilization of renewable energy resources; understanding the land-water interface; consequences and solutions of global climate change; water quality and quantity, carbon sequestration, forest land and wildlife management; natural systems restoration, surface and ground water conservation; management of agricultural waste residue; chemical and electronic waste in urban and rural settings; sustainable soil health enhancement; sustainable eco- and agri-tourism; rural-urban interface environmental issues; and remote sensing and precision agriculture. In addition, efforts continue on sustainable management of pest organisms and diseases in and around homes, landscapes, and natural aquatic and terrestrial environments. Utilizing new and innovative techniques to monitor the environment, develop new strains and varieties, and better understand water and nutrient cycling all aid in managing Alabama's natural resources.

The environment comprises air, animals, fuels, minerals, plants, soil, and water; therefore, addressing sustaining these resources falls under this critical issue. Conservation research caring for these resources benefits all living organisms. However, sustainability preserves them for the future. Alabama's three land grant institutions aim to conduct quality research to better understand how to transition from nonrenewable to renewable resources. A broad range of undertakings is being pursued to preserve the biodiversity of forest systems in Alabama, although increasing attention and demand for biomass are on the rise. New management systems to ensure and increase the role of forests in carbon sequestration are among the priorities in this critical issue to help mitigate climate change. Limiting and decreasing fossil fuel use is being explored by creating alternatives to fossil fuels, including biofuel, electricity, heat from the sun, power from wind, water, and geothermal energy, all of which represent renewable means to sustain a cleaner environment.

Farming methods practices to decrease soil erosion and runoff of chemicals are key areas of research that are providing new methods to modify conventional practices to increase sustainability. New areas of research focusing on soil microbiomes to unlock the knowledge gap in soil health are being carried out by all the institutions. Modern precision farming systems are being explored with the newest

available technologies including artificial intelligence (AI) systems. Through seminars and webinars, new findings are being transferred to stakeholders. Programs to incentivize the transition to more sustainable practices are highlighted and emphasized by the State’s Extension System. Water use efficiency to minimize increasing shortages from drought and other industrial procedures, also represent a crucial area of research for this life-sustaining resource.

Critical Issue: Sustainable Energy and Bio-based Products

Agricultural research in Alabama contributes to the national goal of energy independence by supporting science to develop biomass used for biofuels, design optimum forest products and crops for bioenergy production, and produce value-added bio-based industrial products. Specific areas of research are focusing on alternative crops for efficient production of bioenergy feedstock, biotechnology of bioenergy crops to enhance production or to enhance its utilization as an energy source, development of nanocellulose-based materials, and technology development, including the anaerobic digestions and algae, for bioenergy conversion of agricultural wastes.

The three land-grant institutions in Alabama are increasing their focus on research that will enable the transition from fossil fuels to bioenergy by taking advantage of its rich and diverse biological resources, which can be used for different fuels. Having favorable climatic conditions, including mild winters satisfactory for the production of winter crops such as rapeseed, canola, flax, and others, represent unique, advantageous opportunities for the region. Additionally, a long summer growing season also allows the exploration of a multitude of plant species with promising potential for renewable energy, including biofuels for sustainable aviation fuels (SAF), low-emission vehicle fuels, heat, and electricity. Beyond fuels, attention is also directed toward research to create bio-based products for a sustainable and circular economy.

Bio-based products may be partly derived from biological materials, reducing fossilized-based inputs. New enzymes, cleansing agents, blends of different fibers for paper, textiles, construction products, etc., are among the concepts pursued with different plant species. New bio-catalysis processes to increase the efficiency of fermentation are being pursued to decrease energy and water consumption and reduce toxic waste in the industrial sector. These renewable undertakings reduce CO2 emissions and increase biodegradable materials for a cleaner environment.

Bio-based products and biofuels continue to increase annually by increasing revenue in the agricultural sector and creating the demand for developing a new well-trained, and qualified workforce. Research in renewable energy is also aimed at closing the knowledge gap to understand better system integration to sustainably achieve net-zero energy production. Achieving the net-zero goal, deployment, and commercialization must also be socially acceptable and be integrated in the overall research components in the critical issues of sustainable energy and bio-based products.

Merit and Scientific Peer Review Processes

Updates

None. No updates.

Stakeholder Input

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

None. No updates.

Methods to identify individuals and groups and brief explanation

None. No updates.

Methods for collecting stakeholder input and brief explanation

None. No updates.

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

EXTENSION:

Strategic program initiatives were identified from the comprehensive grass-tops and grassroots needs assessment activities. Program leaders collaborated on the development of a logic model for each strategic program initiative focusing on specific objectives, outputs, and outcomes that allowed for application across various program areas. Each logic model includes an evaluation plan.

Program leaders assisted their respective program teams, consisting of Extension specialists, agents, resource specialists, and farm management specialists, to prepare plans-of-work. Steps included: 1) determining which strategic program initiatives fit with the team's capabilities and resources and to develop a programmatic responses consistent with the objectives, outputs, and outcomes of the respective strategic program initiative logic model, and 2) completing the program team plan-of-work to include ongoing programs or special funded projects. A quarterly staff conference was used to process stakeholder input from the special and state advisory councils as a special effort on behalf of limited-resource and low-asset communities in the Black Belt.

Team plans of work were shared with Extension coordinators, agents, and resource specialists to align program alternatives and to make mutual decisions regarding programs, staff involved, dates, and locations for implementation purposes.

RESEARCH:

Input from stakeholders was used to set program priorities and for identifying emerging issues relevant to agricultural activities. Their inputs were considered in the long-term plan for hiring faculty members and staff members. Input concerning urgent and serious issues was used to redirect research funds and used in the budget processes as well. Research priorities identified from stakeholders' input were used as guides for solicitation of research grant applications. Annual Hatch and Evans-Allen-funded internal grants were selected competitively (awards are made based on merit and relevance to the priority areas). Because of the small size of the funding, such research funding has to be considered as seed grants. Leveraging of additional funding was essential to carry the research priorities forward.

Highlighted Results by Project or Program

Critical Issue

Community Development

[Excite Project \(A2\) - \(Annual\)](#)

Project Director

Matthew Ulmer

Organization

Auburn University

Accession Number

7004565



Excite Project (A2) - Annual

Final Result

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

Alabamians remain among one of the least vaccinated populations in the US for COVID-19. As this contagious virus continues to work its way through communities, reminders of risks and prevention measures are critical to protecting Americans from some of the potentially devastating effects COVID-19 has caused to numerous Americans. Since its inception, over 1.6 million cases of COVID-19 have been recorded in Alabama. Since the beginning of 2023, 38,572 cases of COVID-19 were reported. Consequently, ensuring Alabamians are conscious of the need to stay diligent in their COVID related prevention efforts is still a necessary step toward keeping our society healthy.

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.

Vaccination clinics and information sessions were offered across Alabama with emphasis placed on serving underrepresented populations. These concerted efforts utilized customized approaches tailored to engage these groups in ways that promote and engender trust and access for these groups. In 2022, we partnered with the Alabama Coalition for Immigrant Justice and the Alabama NAACP to coordinate clinic and information session activities for many individuals who are reluctant, or unwilling, to seek medical attention through more conventional means.

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

Excite program efforts have yielded 33 live and virtual events reaching 2,737 individuals. Over 200 social media posts were made reaching as many as 18,000 or more from our Extension social media accounts. Over 2,300 print materials have been distributed. Over 13 vaccination clinics were held providing covid-19 vaccines to 138 Alabamians.

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

The broader public benefitted from increased numbers of vaccinated persons as vaccinated persons are less likely to contract the virus or experience the most severe symptoms and outcomes of the virus compared to their unvaccinated peers. Since the grant performance period began, Alabama's single dose vaccination rate has risen from 30% to 64%. We believe our educational materials and continued health clinic efforts will increase vaccination numbers and improve Alabamian knowledge of COVID-19 vaccine related facts.

Job Success - Annual

Project Director

Matthew Ulmer

Organization

Auburn University

Accession Number

7004566



Job Success - Annual

Final Result

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

Turnover remains a significant issue for many Alabama businesses. Many employees are terminated due to reliability or behavioral issues in the workplace. Job Success aims to address these issues by providing participants a basic overview of the soft skills needed to meet employer expectations and success strategies to help them be a strong, dependable employee capable of maintaining employment.

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

Curbing turnover is to the benefit of both the employer and employee. Job Success prepares participants for the workplace by ensuring they understand the basic principles of being a good employee capable of meeting their employer's expectations. As turnover is reduced, the employer benefits significantly as institutional knowledge among their employees increases, fewer dollars budgeted to hire and train employees are invested thus creating opportunities for the business to reinvest their resources into the business. For the employee, their ability to perform both from a soft and technical skills perspective in the workplace helps them build a track record of success allowing them to grow professionally.

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

The Job Success program is a four-module series designed to provide employed individuals with a foundational understanding of employer expectations, equip participants with decision making, time management, and communication skills, and expose participants to key strategies to minimize conflict, appreciate differences, and understand differences among personality types.

Job Success program assessments uncovered 74% of participants increased their understanding of topics covered by the program. More specifically, participant pre and posttest assessment responses revealed statistically significant increases in knowledge of the impacts of possessing a positive attitude in the workplace, not making assumptions when workplace communications are unclear, valuing differences among teammates, and understanding the characteristics and importance of being a team player occurred. Overall, 80% of Job Success participants plan to apply the knowledge gained in the professional and personal lives.

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

As businesses cut turnover and have more reliable, competent employees, productivity increases, and turnover costs decrease thus leaving them with more capital to invest in hiring new employees and growing their businesses. Roughly 100 individuals in three employment settings received job success training with over 90 receiving the full series. We are awaiting turnover impact information; however, commentary from participants and employers alike was resoundingly positive.

Ready Community - NIFA Disaster Preparedness Project 1 - Annual

Project Director

Matthew Ulmer

Organization

Auburn University

Accession Number

7004568



Ready Community - NIFA Disaster Preparedness Project 1 - Annual

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

Volunteer organizations are often a critical component of the front-line response team with volunteers eager to help with storm related issues. In their passion to offer help, efforts made by volunteers lacking training can get in the way of EMA and others trying to facilitate recovery response efforts. Our project will provide a resource to communities for integrated trainings which would include digital resources, print resources, and in person offerings. This wholistic training method is designed to connect disaster preparedness best practices from EMA and others to those involved in the local response process. The projected outcomes of this program will make a positive impact on Alabama communities by providing a single resource to guide the collaborative efforts of EMA leaders, Extension, and community volunteer organizations and their volunteers.

The outcomes of this project will be:

1. The developed learning modules and their associated educational content will establish a platform for meaningful collaboration between EMA leaders, local governmental leaders, and community volunteers that can be sustained by Alabama Cooperative Extension specialists, CECs and Auburn University Agricultural Educational faculty.
2. A scalable application of educational and training curriculum, by leveraging the EDEN network to create a community of practice that can be built upon to meet needs for others facing disasters.
3. Online educational video curricula modules and in person training materials will ensure local disaster teams will have the tools and skills necessary to identify critical needs, provide timely assistance, and support recovery efforts before, during, and after an emergency incident.

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.

Utilizing the Ready Community Curriculum, County Extension Coordinators in up to 18 counties will develop strategic plans and communications efforts working alongside existing and refreshed volunteer organizations active in disaster (VOAD) groups. These efforts should help create clear support mechanisms for EMA and these entities to leverage when disaster related issues occur.

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

Our target audiences include EMA, nonprofit, and community leaders. Together, Extension will work closely with VOAD groups to develop a county-specific strategic plan built to assist in the implementation of disaster recovery. Further, inventories of resources, contact information, and more will be collected for all involved in disaster recovery to access as needed. Our project has yielded two main accomplishments thus far. The first accomplishment was the successful development and

implementation of a comprehensive needs assessment which will inform our activities as researchers and practitioners in carrying out our project. The data collected from the needs assessment verified our initial hypotheses regarding the need for additional coordination and support of volunteers and other similar groups to increase efficiency of EMA leadership in the mitigation, preparation, response, and recovery processes. Additionally, the needs assessment findings also demonstrated a tremendous need to provide education to community members regarding disaster mitigation and preparation practices. These findings have informed our curriculum development and prompted the need for additional funding to address educational challenges among Alabamians on these topics.

The second accomplishment was the successful revamping of the existing Ready Communities curriculum which will become the backbone of our training and education efforts among those participating in traditional VOAD operations at the county level. This curriculum was updated to reflect more common gathering and engagement practices following COVID-19 and sought to focus more on engaging more groups beyond the traditional scope of EMA volunteer groups.

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

The broader public will benefit from the greater communication, efficiencies, and access to resources during disaster response and recovery as part of these efforts.

Your Money, Your Life - Annual

Project Director

Matthew Ulmer

Organization

Auburn University

Accession Number

7004567



Your Money, Your Life - Annual

Final Result

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

Career exploration and financial literacy skills are invaluable tools for youth to possess as they consider their transition from school to the workforce. Your Money, Your Life provides career exploration and financial literacy education to middle and high school students. The program focuses on exploring career clusters, considerations for choosing a career, conducting a financial literacy simulation, and discussion of financial literacy topics such as budgeting, reading a pay stub, writing a check, and more.

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 YMYL program is delivered in three sections. The first section is comprised of an overview of career clusters with a focus placed on highlighting local area job opportunities. Further, the first session highlights career choice considerations such as pros and cons of more education, personal values concerning career and more. The second module features a simulation where participants will make financial decisions just like they would in the real world. The third module focuses on financial literacy and walks students through the pros and cons of certain financial decisions, how their pay stub looks and an introduction to certain taxes, and how to craft a budget of their own.

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

Increasing the exposure of career opportunities to middle and high school youth is a critical workforce development tool. Many young adults do not have a clear concept of what job opportunities are available close to them or even regionally. Further, the financial considerations needing to be weighed as career opportunities are explored are equally as important. Your Money, Your Life provides a great overview of the facts regarding these topics and provide numerous active learning opportunities for participants to learn more about how career choices and their financial future is linked. Last program year, over 6,500 students from 35 counties participated in the YMYL program. Evaluation tools indicated statistically significant knowledge change among participants in 6 out of 6 target survey items.

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

The broader public benefits from this program as equipping the future workforce with critical information as to what career opportunities may be available to them is a strategic point of advantage for future employer recruitment. As these students increase their awareness of career opportunities available to them locally, regional employers are better positioned to recruit and retain local talent to build and sustain their businesses.

Critical Issue

Family, Home, and 4-H and Youth Development

Greater Alabama Black Belt Region (GABBR) S.T.E.M. Academy

Project Director

Amelia Mitchell

Organization

Auburn University

Accession Number

7004611



Greater Alabama Black Belt Region (GABBR) S.T.E.M. Academy

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

Most students within the Black Belt counties are not prepared for the next grade level, especially in STEM disciplines. According to data released by the University of Alabama Education Policy Center, just 11% of K-12 students scored high enough on state assessments to be considered 'proficient' or ready for the next steps after high school graduation. More specifically, both Lowndes and Bullock counties had less than 1% of students considered proficient in Math. Yet, STEM careers are expected to increase 10% by 2030, paying roughly double those of other jobs.

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

To address this challenge, the Academy focused on providing summer supplementary instruction in the subjects of English, Mathematics, and Science courses for rising 7th through 12 grades. Areas of learning targeted specific courses where student performance deficiencies were present, with the ultimate goal to increase scores by one letter grade within 5 weeks.

In 2022, the overall mean of the average scores improved by 43 points, from 44% to 87%. Science scores increased from 50% to 86%, and Math scores increased from 39% to 72%.

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

Using a 5-point scale (1=Strongly Disagree, 2= Disagree, 3=Neither, 4=Agree, 5=Strongly Agree), students and parents rated the extent to which the Academy benefitted students. While many benefits were identified, both students and their parents indicated that the Academy provided a meaningful opportunity for students to work with professionals in the STEM field, established a positive relationship with a mentor, and learned things that they will use in school by gaining valuable knowledge in Mathematics, English, and Science. Overall, parents reported that the Academy met their expectations to a great extent, especially in terms of making them proud (M=4.90), in making their child proud (M=4.90), and learning things that will be useful in classes during the academic year (M=5.0).

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

The overall goal of the Academy is to increase college readiness among students by expanding their content knowledge and confidence in core subject areas, allowing them to progress along a path toward college/university admission and successful studies in STEM. At the end of the Academy, 100% of students and their parents indicated that they would be attending college with 90% of students and 100% of their parents expecting students to complete a minimum of a bachelor's degree.

Health Rocks!: Vaping Curriculum

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7004661



Health Rocks!: Vaping Curriculum (ANNUAL)

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

Vaping is on the rise among American teens. A recent study by “The Truth Initiative” found that 27.5 percent of American high school students use vape products, like e-cigarettes. Teens who vape need the right motivation and education to quit. Wanting to be the best, healthiest version of themselves is an important reason to quit vaping.

The objectives of the Health Rocks program are to help youth learn skills such as decision-making, critical thinking, and stress management while placing an emphasis on the prevention of tobacco, drug, and alcohol use.

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 lessons from the vaping curriculum empowered students with the knowledge and skills needed both to make informed decisions about e-cigarettes and to resist social pressures to vape. The classroom lessons are based on cooperative learning groups, group discussions, goal setting, and activities such as analyzing tobacco and nicotine vaping advertising and developing counter-advertising messages.

After a series of four lessons taught to (n=743) elementary-aged students, there was an increase in nicotine vaping knowledge (89%) and positive perceptions of a vape-free lifestyle (64%).

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

This program benefited elementary-aged students by preventing addiction and related chronic diseases as a result of vaping or e-cigarettes. Students were able to identify marketing tactics used by nicotine companies to target young people as well as the health risks of vaping. Differentiating between the myths and facts about vaping increased students' knowledge of vaping and other nicotine products.

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

Community stakeholders, school leaders, parents, and youth-serving organizations benefited from the vaping curriculum during Drug-Free Week. 4-H agents delivered content including statistical facts related to vaping among teens. Lessons provided critical knowledge about how vaping products can be detrimental to a person's health, as well as how e-cigarette marketers intentionally target young consumers. When parents have knowledge of the dangers of vaping, they can share the knowledge with their children and across communities.

Science, Technology, Reading, Engineering, Agriculture and Mathematics (STREAM)

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7004659



Science, Technology, Reading, Engineering, Agriculture and Mathematics (STREAM) (ANNUAL)

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

Enhancing STEM competence (e.g., interests, knowledge, skills, and dispositions) among urban, high-poverty, elementary through high school populations in the United States remains a national concern, especially since STEM competence is and will continue to be a prerequisite for thousands of vacant positions in the future, according to workforce development experts.

The goal of the Science, Technology, Reading, Engineering, Agriculture, and Mathematics (STREAM) program is to 1) provide youth with experiential learning opportunities with an emphasis on improving reading comprehension skills and subject-matter content (i.e. science, technology, reading, agriculture, and engineering) (2) use research-based reading strategies to help youth process information gained from expository text, (3) use scientific skills and methods to carry out science experiments and (4) introduce youth to STEM skills and careers using curriculum developed for use on the STEM Mobile Unit.

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.

By developing and implementing culturally responsive pedagogy from the STREAM Curriculum, 4-H agents were able to build upon the strengths and talents of 8,334 urban elementary youth. Culturally responsive pedagogy and the use of children's literature during STREAM instruction have been shown to positively impact youth effort and engagement in STEM. Specifically, 71% of the youth were highly interested in STEM careers after a series of six lessons, including STEM Day; 84% were able to identify the steps of the scientific method and draw conclusions from data; and 59% of girls showed growth in STEM interest and curiosity.

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

Early STEM education provides the necessary foundation for individuals pursuing degrees and careers in the field. The STREAM curriculum is centered around activities designed to help students gain the skills required to succeed in the innovation-focused ever-evolving job market. However, many students in underserved schools and communities lack the resources and opportunities to pursue careers in the STEM field. Even earlier on, urban students across the country are not receiving adequate education in these subjects. Implementation of the STREAM curriculum in urban schools with a large number of underserved youth has expanded the opportunity for youth to obtain knowledge of STEM concepts and skills that are needed in the workforce. Exposure to STEM-related books that discuss STEM practices helped youth to develop a greater conceptual understanding of STEM and of the efforts required to be successful in STEM.

78% of youth gained STEM skills such as problem-solving, analyzing, reasoning, and drawing conclusions when conducting STEM lessons via hands-on learning.

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

By adopting a more culturally responsive pedagogy and curriculum that attends to the 21st Century Learning Skills and the Next Generation Science Standards, underserved and underrepresented children statewide have the opportunity to be introduced to and engage deeply in and benefit from reinforcement in STEM learning. Moreover, these students have a greater likelihood to enter careers in STEM as adults, which benefits all of society.

4-H Volunteerism

Project Director

Mary Gregg

Organization

Auburn University

Accession Number

7002155



4-H Volunteerism, Annual

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

*To create positive youth development opportunities for Alabama youth age 5-18 to experience 4-H in safe and secure environments where youth have opportunities to belong, gain independence, master skills, and show generosity to others while finding their "spark".

*Alabama 4-H needs: To leverage volunteers to further educational efforts and provide subject matter expertise; Properly screen and enroll 4-H volunteers; Ensure 4-H volunteers and staff are prepared, competent, and empowered to implement 4-H programs; To recognize outstanding accomplishments of 4-H volunteers to add in volunteer recruitment and retention.

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.

*109,745 Alabama 4-H Members are safer because of stringent screening, training, and orientation procedures for 4-H volunteers in the area of: sexual misconduct, identifying reporting and preventing abuse, diversity and inclusion, ages and stages of positive youth development, risk management, and first aid and safety.

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

"Safety doesn't happen by accident" - Unknown; Alabama 4-H will continue to make intentional efforts to keep kids, volunteers, staff, and our programs and communities safe and secure while providing high quality 4-H events, activities, and programs to help 4-H members explore their interests and find their sparks.

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

*4,563 Alabama 4-H Volunteers modeled service to their communities resulting in 109,745 youth who are now four times more likely to make contributions to their communities and two times more likely to be civically active (4-H Study of Positive Youth Development, 2002). *Alabama 4-H Volunteers impacted ACES by providing 92,465 hours of service valued at \$2.76 million or the equivalent of 46 FTE. *Staff and 4-H Volunteers managed 3,180 4-H Clubs where young people gain skills, supplement classroom learning, and explore interests. 1,119 4-H Community Clubs, 1,907 4-H In-School Clubs, 149 4-H Afterschool Clubs, and 5 4-H Military Clubs.

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.

Major priorities continue to be: - Onboarding of new 4-H employees -4HOnline Enrollment System - 4HOnline New Users & Administrative System Training -National 4-H Week Promotional Materials and Opportunities -Alabama 4-H Volunteers of the Year -Ongoing Additional Educational Modules -Ongoing Program Assessment and Revisions

Money Smart for Adults

Project Director

Paul Brown

Organization

Auburn University

Accession Number

7002293



Money Smart for Adults (Annual)

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

Money Smart for Adults equips adults with the practical knowledge and resources to manage their finances confidently. Individuals establishing their financial lives, credit histories, and others who want to improve their financial situation are the target audience. The program was primarily aimed at adults in Alabama and included some teens and out-of-state participants.

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 2022 a total of 5,929 participants (56.3% Male, 43.7% Female) learned about money management through 11 modules on banking, borrowing, checking & saving, personal spending plan, protecting consumer rights, understanding and utilizing credit, loans, homebuying, and financial recovery, across the 5-lesson Money Smart for Adults curriculum.

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

There were significant increases in knowledge about money management skills in five topic areas: banking, credit, identity theft, saving, and spending planning. Intentions to take specific actions after participating in Money Smart increased across all sessions. Results per topic area are presented below.

Credit: A subset of 152 participants, 7.32% intended to actively reduce debt, and 12.11% planned to obtain a secure credit card to build credit.

Identity Theft: A subset of 574 participants' intention to request a free credit report 3 times a year increased by 8.9%.

Saving: 19.77% of participants plan to increase saving by \$162 per month on average. 8.1% set an intention to start an emergency fund, and 14.6% plan to begin the practice of saving change each week toward a future goal.

Spending Plan: In a subset of 116 participants, 14.1% of attendees set an intention to use the Money Management calendar provided by Alabama Cooperative Extension (ACES), and 13.4% intend to use the ACES Goal Setting Worksheet. 17.9% of participants set a SMART financial goal due to attending the session.

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

For many Americans, living paycheck to paycheck is a reality. Approximately one in every four Americans has difficulty paying their bills. Financial literacy, acquired through financial education, enables people to make informed decisions about their money, thereby increasing financial well-being. Financial literacy is a national and statewide goal.

Skills to Pay the Bills: Career Development

Project Director

Paul Brown

Organization

Auburn University

Accession Number

7002299



Skills to Pay the Bills: Career Development (Annual)

Final Result

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

The Financial Resource Management and Workforce Development Team leads a statewide career development project called Skills to Pay the Bills. The intended audience is 14 to 19-year-old school and out-of-school youth. Skills to Pay the Bills is an activity-based program that teaches Alabama youth how to navigate school, work, and personal lives.

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 2022, as part of Skills to Pay the Bills, three Regional Agents taught four lessons and 185 activities to 6,426 youth and young adult participants in 8 counties. The composition of participants was 46.8% Male, and 53.2% Female).

Agents delivered lessons both as a series and individually. Across the 4-lesson skills to pay the bills curriculum, participants learned soft skills that contribute to stronger relationship building, overcoming workforce challenges and conflict, change adaptability, and making meaningful workplace contributions throughout. The objectives for each are: Communication Skills - Learn how to provide information - Understand forms of communication - Explore active listening techniques; Teamwork

Learn emotional IQ, how conduct affects others - overcome obstacles to successful teamwork - Develop positive teamwork behavior; Problem Solving & Critical Thinking Skills to identify solutions - Chain of command; and Workplace Enthusiasm & Attitude - Demonstrating enthusiasm - improve negative thinking patterns

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

Among participants, there were significant increases in knowledge about workforce interpersonal skills in four areas: communication skills, teamwork, problem-solving & critical thinking, enthusiasm & attitude. Results for each area are summarized below.

Communication skills: In a subset of 561 participants, the ability to use two-way communication increased by 24.8%, awareness of non-verbal communication with others increased by 20.8%, and knowledge of taking task-related directions increased by 16.29%.

Teamwork: In a subset of 398 participants, understanding the importance of teamwork increased by 19.98%, knowledge of team member roles and contributions increased by 21.7%, and the ability to recognize one's own strengths and needs in a team increased by 25.3%.

Problem-Solving & Critical Thinking: In a subset of 76 participants, the ability to demonstrate ethical decision-making on the job increased by 10.23%, the ability to discern the difference between criticism, praise, and feedback increased by 11.22%, and the ability to consider diverse perspectives by increased 10.48%.

Enthusiasm & Attitude: In a subset of 382 participants, the ability to recognize when actions demonstrate a negative attitude increased by 15.1%, understanding that failure is a part of learning and growing increased by 16.9%, and understanding that displaying a positive attitude is a key factor in obtaining and retaining a job increased by 11.04%.

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

Soft skill development is an important part of healthy adolescent development. According to three-fourths of employers, the incoming workforce is unprepared for the job market and lacks a strong work ethic. Eighty-eight percent of managers believe new hires must have a strong work ethic to succeed. Soft skills help people develop traits like character, confidence, and caring, and they serve as a foundation for people to grow and live as productive members of the workforce and society.

Successful Aging Initiative

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002376



Successful Aging Initiative (Program - ANNUAL))

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

The issue of aging is critical throughout the United States because the number of individuals 65 years and older is projected to double by 2040. The number of individuals 85 years and older will nearly quadruple between 2000 and 2040. For the first time in history, people who are 65 years and older will outnumber children five years and younger. Societal aging, in Alabama as elsewhere, presents significant challenges for not only families but also the health care system, economic system, the job market, and nearly all aspects of society. The Successful Aging Initiative provides materials and resources that are useful to seniors, caregivers, and family members with a focus on helping older adults maintain their quality of life.

Target Audience: The target audience for this program is limited resource older adults. Of the 2,810 individuals who participated in the SAI program, nearly 100% were from urban areas in the state. Demographics collected for 2,810 participants indicated that 91% of the participants were adults, with 8.5% not responding. Females made up 66% of the audience. Whites made up more than half of the participants (56%), Blacks roughly 40%, and all other races approximately 3%. Seven (7) of the participants were of Hispanic origin.

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 the 160 activities used to accomplish the program's goals and objectives, the major activities were workshops offering a series of lessons. Other activities included conferences, resource distributions, participation in health fairs, food drives, estate planning sessions, free will clinics, social events to keep older adults connected, tv interviews, radio interviews, social media posts, publication of newsletter articles, flyers, workbooks/activity books, newspaper articles, and a peer-reviewed journal article. A series of lessons were used to help accomplish the program's goals and objectives. Comparison of the pretest and posttest scores indicated a significant percentage change or increase in participants' knowledge or understanding of the following:

Fraud and Scams (n = 464):

- Why older adults are targeted more than other age groups (32% increase)
- How to identify different ways a person's identity can be stolen (34% increase)
- How to identify common scams used to take advantage of older adults (34% increase)
- How to protect themselves against common scams used to take advantage of older adults (32% increase)
- How to report fraud (33% increase)

The mean score for participants' overall knowledge of fraud and scams and how to protect themselves increased by 33%.

Fall Prevention (n = 406):

- How age-related changes can increase their risk of falling (23% increase)
- How their behavior/choices can increase their risk of falling (31% increase)
- How to check their home and surroundings for fall risks (36% increase)
- At least five ways to decrease their chances of falling inside their home (39% increase)

The mean score for participants' overall knowledge of falls and how to reduce their risk of falling increased by 33%.

Decision Making (n= 312):

- Strategies they can use when making buying decisions (40% increase)
- Tools and resources needed to make buying decisions that will help in managing spending more effectively (38% increase)
- How to calculate the unit price of items or use shelf price labels for comparison (40% increase)
- How certain buying behaviors can prevent smart buying decisions (34% increase)
- Importance of using the decision-making process when purchasing large or expensive items (36% increase)

The mean score for participants' overall knowledge of the consumer decision-making process and its impact on their buying decisions increased by 37%.

Healthy Aging (n = 344):

- Healthy aging (68% increase)
- Importance of anticipating problems, needs or changes related to aging before they happen (29% increase)
- What it means to be proactive about aging (53% increase)

- Age-related stressors that impact their quality of life (45% increase)

• After the lesson, there was a 45% increase in the number of participants indicating that they would start thinking about and planning for aging.

• After the lesson, there was a 61% increase in the number of participants indicating that they would start planning how to reduce, prevent, or eliminate age-related stressors.

The mean score for participants' overall knowledge of healthy aging and how to become proactive about aging increased by 48%.

Estate Planning (n = 267):

Comparison of the pretest and posttest scores indicated a significant percentage change or increase in participants' perceptions of the importance of the following:

- Will (37% increase)
- Power of Attorney (23% increase)
- Living Will (23% increase)
- Health Care Proxy (18% increase)
- Trust (18% increase)
- Checklist for organizing important papers (15% increase)
- Secure place for storing important papers (15% increase)
- After the lesson, 27% more of the participants indicated that they would begin working on obtaining or updating their will.
- After the lesson, 32% more of the participants indicated that they would begin working on obtaining a living will.
- After the lesson, 27% of participants indicated that they would begin working on organizing their important papers.

The mean score for participants' overall knowledge of estate planning and various tools needed for estate planning increased by 25%.

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

More than a month after participating in the program, participants continued to use the information and skills gained from the program. Based on results from the delayed post-assessment (n = 154), many of the participants have reported the following changes in behavior:

- Adopted healthier habits relative to aging (87%).
- Become proactive about aging (88%).
- Started to expect age-related challenges and plan for them (89%).
- Made changes in their behavior and choices to help adjust to age-related challenges (91%).
- Made changes in their environment to prevent the risk of falling (84%).
- Periodically checked their home and environment for things that can cause them to fall (81%).
- Increased active awareness of age-related changes (i.e., eyesight, poorer balance, etc.) and their environment (90%).
- Looked for signs of identity theft/fraud/scams (89%).
- Used different strategies to protect their identity (88%).
- Stopped providing sensitive, personal, or financial information on the phone, by email, or through surveys (80%).

- Stopped sending money to anyone that they have only communicated with online or by phone (83%).
- Started taking time to identify and weigh their options before buying large/expensive items (83%)/
- Started using shelf price labels to compare prices (71%)
- Started avoiding the urge to buy out of habit, spur of the moment, and for recognition or status (79%).

Estate Planning delayed post-assessment (n = 141) indicated the following changes in participants' behaviors:

- Talked with a family member(s) or a trusted individual regarding their estate (85%).
- Talked with a family member(s) or a trusted individual regarding their future health care (87%).
- Talked with a family member(s) or a trusted individual regarding the location of their important papers (89%).
- Created a will (75%).
- Created a living will (72%).
- Appointed a health care proxy (76%).
- Appointed a power of attorney (74%).
- Organized their important papers for easy access (86%).

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

Although approximately 2,810 individuals benefitted directly from the program, the broader public also benefits from the program outputs in the following ways:

- Reducing the number of older adults losing millions of dollars to scammers reduces the financial burden and amount of stress/anxiety experienced by older individuals and their family members. This undoubtedly will help improve the overall financial status of older adults and their family members, and it will also help prevent stress-related health issues.
- Identifying and reducing the number of fall hazards in and around the home can result in fewer accidents and deaths. Since falls among older adults often result in substantial medical expenditures, this program benefits the broader public by reducing the medical cost of fall-related injuries.
- Being proactive about aging can result in more individuals being able to age in place. Aging in place helps individuals maintain their independence, slows the advancement of memory loss, improves their quality of life, and reduces the chances of contracting a severe illness. Having a greater number of individuals age in place helps the public by lowering the cost of care for family members and the public. It will also benefit the public by having this large segment of the population healthier and happier to participate in all aspects of society more effectively.
- Increasing older adults' ability to manage their finances and estate more effectively will benefit their loved ones and reduce the burden on the judicial system. Likewise, it can help individuals maintain strong family relationships and help keep and preserve family wealth. Maintaining family wealth can reduce the financial burden on individuals and families as well as reduce the financial cost of public assistance.

Financial Literacy In Progress

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002342



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

The wages of many residents of Alabama are not increasing as quickly as inflation, and many individuals and families are finding their purchasing power decreased. Falling wages and other factors add to the already escalating debt of many households. In Alabama, 35.6% of its working families have a median income below 200% of the federal poverty level. Compared to 2020 data, debt in nearly every category is up. Given that lower incomes, higher prices, and debt have nearly wiped out many household budgets, the number of individuals and families struggling financially to meet basic needs has increased. The goal of the Financial Literacy in Progress program is to increase participants' knowledge & skills needed to understand personal finance and improve their financial well-being.

The target audience for this program is limited resource adults of all ages. Of the 2,162 individuals who participated in the Financial Literacy in Progress Program, approximately 100% were from urban areas in the state. Demographics collected for 2,162 participants indicated that more than three-quarters of the participants (79 %) were adults, 19% were youth, and 2% did not respond. Males made up 57% of the audience. Whites made up a little more than half at 51%, Blacks at roughly 39%, 6% did not respond, and all other races approximately 5%. Approximately 2% of the participants self-identified as Hispanic.

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 the 173 activities used to accomplish the program's goals and objectives, the major activities were workshops offering a series of lessons. Other activities included resource distributions, participation in health & finance fairs, various social events to keep older adults connected, tv interviews, radio interviews, social media posts, publication of newsletter articles, flyers, workbooks/activity books, newspaper articles, and schools' career day programs. A series of lessons were used to help accomplish the program's goals and objectives. Comparison of the pretest and posttest scores indicated a significant percentage change or increase in participants' knowledge or understanding of the following:

Credit (n=400):

- The importance of knowing what is on a credit report (29% increase)
- How to request your credit report (40% increase)
- At least three things they can do to build their credit (44% increase)
- At least three things they should not do relative to building and maintaining their credit (47% increase)

The mean score for participants' overall knowledge of credit and how to build and maintain good credit increased by 40%.

Spending Plan (n = 452)

- The importance of tracking their spending (26% increase)
- The importance of having money saved for emergencies (22% increase)
- The importance of using a written spending plan (34% increase)
- How to use a spending plan to help achieve their financial goals (38% increase)
- How to use a spending plan to help manage and control their spending and saving (38% increase)

The mean score for participants' overall knowledge of how to create and use spending and saving plans increased by 32%.

Decision Making (n = 249):

- Strategies they can use when making buying decisions (34% increase)
- Tools and resources needed to make buying decisions that will help in managing spending more effectively (36% increase)

- How to calculate the unit price of items or use shelf price labels for comparison (34% increase)
- How certain buying behaviors can prevent smart buying decisions (28% increase)
- Importance of using the decision-making process when purchasing large or expensive items (27% increase)

The mean score for participants' overall knowledge of the consumer decision-making process and its impact on their buying decisions increased by 32%.

Debt Management (n = 267):

- Why controlling debt is so important (17% increase)
- Different debt management strategies (38% increase)
- How to use accelerated debt repayment plans (48% increase)
- How to select the best debt management strategy for my situation (51% increase)
- Who I can go to for assistance, if needed, with managing my debt (43% increase)

The mean score for participants' overall knowledge of various ways to manage debt increased by 43%.

Banking (n = 118)

- How banks and credit unions work (45% increase)
- How different accounts work (56% increase)
- How interest is added to accounts (55% increase)
- How to compare interest rates and fees to determine the best deal (60% increase)

The mean score for participants' overall knowledge of banking and the various services offered by banks and credit unions increased by 53%.

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

Approximately two months after participating in the program, participants continued to use the information and skills gained from the program. Based on results from the delayed post-assessment (n = 166), the target audience was able to demonstrate the following skills:

- Research large or expensive items before making a purchase (84%)
- Making financial decisions less impulsively and more deliberately (83%)
- Tracking their spending (80%)
- Avoiding making purchases based on what others think or how others view them (79%)
- Paying bills on time (77%)
- Comparing unit price of items for determining best deals (77%)
- Using a spending plan (71%)
- Using a spending plan to plan their savings (67%)
- Knew what was in their credit report (58%)
- Using a debt management strategy to help manage their debt (53%)

- Requesting their credit report (53%)
- Seeking assistance in managing their debt (45%)

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

Although approximately 2,162 individuals benefitted directly from the program, the broader public also benefits from the program outputs in the following ways:

- Increasing individuals' ability to manage household debt is critical to the financial well-being of families and the overall performance of the U.S. economy. Unmanaged debt can deplete a family's wealth or prevent a family from building wealth. Inasmuch as unmanaged debt has been associated with financial exclusion, family breakdown, lower participation in the labor market, and poor physical and mental health, helping individuals learn how to manage and control their spending and credit contributes to healthier individuals, a more productive workforce, and stronger relationships among family members and non-family members.
- Reducing the number of individuals losing millions of dollars to predatory lenders reduces the financial burden and amount of stress/anxiety individuals and family members experience. It will also allow the family's property to remain within the family (i.e., vehicles). By maintaining ownership of their vehicles, they can maintain access to life-sustaining resources, contribute positively to the workforce, and provide for other economic opportunities. Helping individuals avoid abusive lending practices will also impact their communities. This undoubtedly will help improve the overall financial status of individuals and their family members. It will also help prevent stress-related health issues, leading to healthier families and communities.

Helping Youth Promote Empathy- Bully Prevention

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002445



Helping Youth Promote Empathy- Bully Prevention (ANNUAL)

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

In 2019, about 22 percent of students ages 9–18 reported being bullied at school during the school year, which was lower than the percentage reported in 2009 (28%). Of students ages 9–18, about 15% reported being the subject of rumors; 14% reported being made fun of, called inappropriate names, or insulted; 6% reported being excluded from activities on purpose; and 5% reported being pushed, shoved, tripped, or spit on. Additionally, 4% of students reported being threatened with harm, and 2% each reported that others tried to make them do things they did not want to do and that their property was destroyed by others on purpose. The Helping Youth Promote Empathy (HYPE) program is designed to teach youth and adult participants how to identify bullying behaviors, develop intervention strategies to combat bullying, and recognize the impact bullying and violence have on mental health.

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

To reduce the number of bullying incidences among elementary and middle school students, a series of six lessons were presented to 419 elementary and middle school students. Using scenarios, group discussions and role playing, students learned how to identify bullying behaviors, developed intervention strategies to combat bullying and recognized the impact of bullying by putting themselves "in someone else's shoes." Upon completion of the program, 93% of participants were able to identify the different types of bullying; 77% recognized the impact bullying has on behavior and mental health; and 64% were able to identify strategies for preventing bullying.

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

HYPE benefited both the students and teachers within elementary and middle schools by reducing bullying and violent behaviors as well as physical altercations. HYPE taught empathy and acceptance of others. The students were guided through lessons on how they would feel if they were different from others, which resulted in students realizing that kindness and helping others are positive actions.

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

In order to stop bullying, HYPE tackled several fronts, including school culture, parent involvement, and community engagement during community events. Open discussions with information about violence, changed thought patterns associated with violence, and increased social skills have been shown to reduce violence. Therefore in partnership with youth serving organizations within the community, bullying prevention slogans were printed on pencils and grab bags for community events. During after-school programs, 4-H agents read books about bullying to students and discussed them. Hearing anti-bullying messages from the different adults in students' lives reinforced the message for youth that bullying is unacceptable.

Parent-Child Reading Enhancement Program

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002378



Parent-Child Reading Enhancement Program (ANNUAL)

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

In 2019, the average reading score of fourth-grade students in Alabama was below the national average, according to the National Assessment of Educational Progress. The average score for students eligible for the National School Lunch Program was 30 points lower than that of students who were not eligible. In a climate where a certain section of the population's children is continuously scoring below the national reading proficiency level, helping parents understand why and how to teach their children to read must become a priority for many. The Parent-Child Reading Enhancement Program (PCREP) teaches parents and guardians techniques that will help to improve the reading level and skills of children ages 4 to 6 in five key areas: phonemic awareness, phonics, vocabulary, comprehension, and fluency.

Target Audience: The target audience for this program is limited resource adults of all ages. Of the 192 individuals who participated in the Parent-Child Reading Enhancement Program, 100% were from urban areas in the state. A large majority (92%) of the participants were adults, and 8% were youth. Most of the participants were females (90%). African Americans made up 88% of the participants while Caucasian Americans made up 12%.

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 the 13 activities used to accomplish the program's goals and objectives, the major activities were workshops offering a series of lessons. Other activities included resource distributions, family fun day events, radio interviews, social media posts, publication of newsletter articles, flyers, and workbooks/activity books. A series of lessons were used to help accomplish the program's goals and objectives. Comparison of the pretest and posttest scores indicated the following (n = 70):

- After a series of lessons, the percentage of participants indicating that they know the five major skills of reading more than doubled.
- After a series of lessons, the percentage of participants indicating that they use the five skills of reading when teaching a child to read more than doubled.
- After a series of lessons, the percentage of participants understanding phonemic awareness increased by 64%.

- After a series of lessons, the percentage of participants understanding reading comprehension increased by 64%.

- Comparison of participants' pretest and posttest rating of their ability to teach a child how to read increased by 29%.

On a scale from 1 to 10, 90.5% of the participants (post) compared to 70.1% (pre) rated their ability to teach reading between 6 and 10.

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

Approximately one month after participating in the program, participants continued to use the information and skills gained from the program. Based on results from the delayed post-assessment (n= 21), the target audience reported the following:

- Using the five reading skills to help teach a child reading (95%)
- Using strategies taught in class to teach reading (100%)
- Witnessing improvement in children's reading ability (100%)
- Experiencing improvement in their ability to teach reading (100%)
- Increasing the amount of time they spend reading with a child (100%)

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

Although approximately 192 individuals benefitted directly from the program, the broader public also benefits from the program outputs in the following way:

- Since the level of reading proficiency in the fourth grade is a strong indicator of high school dropout or progression, improving adults' ability to teach children how to read can impact children's ability to read, which contributes to a reduction in high school dropout rates. Reducing dropout rates improves the quality of life for the youth as they become adults and productive community members. This also saves the U.S. billions in lost earnings, lost tax revenues, and expenses for social services.
- The stress and anxiety that parents, family members, and teachers experience while working with children having difficulty reading can be reduced. Reduced stress and anxiety can lead to improved physical and mental health.
- Children become proficient readers, leading to increased confidence, and improved academic performance over time.

Promoting Readiness for Employment Possibilities

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002377



Promoting Readiness for Employment Possibilities (PREP) (ANNUAL)

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

With nearly ten years of economic growth in the U.S., a substantial number of jobs are now available. However, a gap exists between the job skills that employers seek and the skills and competencies that many job seekers possess. Based on the 2016? 2026 projected skills gap indexes, given in the State of the Workforce Report XIII?Alabama (2019), basic and social skills are the most critical skills with a strong need for training. The goal of the Promoting Readiness for Employment Possibilities (PREP) program is to support those currently looking for a job or interested in a career change by:

- Explaining what to include and what not to include on a resume.

- Teaching how to apply for a job using paper and online applications.
- Providing examples of how to answer interview questions.
- Describing the right clothes to wear to an interview.
- Developing soft skills that are important on a job: communication, teamwork, leadership, and reasoning skills.
- Planning alternate career paths and identifying the steps needed to make the change.

The target audience for this program is limited-resource older adults and youth in their late teens. Of the 1,411 individuals who participated in the Promoting Readiness for Employment Possibilities (PREP) Program, 100% were from urban areas in the state. Demographics of 1,204 participants indicated that more than half (63 %) were adults and 37% were late teens. Males made up 53% of the audience. African Americans made up 48%, Whites roughly 44%, and all other races 8%. One percent of the participants self-identified as Hispanic.

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 the 93 activities used to accomplish the program's goals and objectives, the major activities were workshops offering a series of lessons. Other activities included conferences, resource distributions, participation in job fairs, mock interviews, resume clinics, tv interviews, radio interviews, social media posts, publication of newsletter articles, flyers, workbooks/activity books, and newspaper articles. A series of lessons were used to help accomplish the program's goals and objectives. Comparison of the pretest and posttest scores indicated a significant increase in the number of participants (n = 276):

- Having resumes (84% increase)
- Who believe their resumes are adequate for helping them obtain employment (66% increase)
- Who know how to complete a job application (6% increase)
- Who know how to complete an online job application (5% increase)
- Who know how to answer questions during a face-to-face interview (11% increase)

After completing the program, participants were significantly more confident in their ability to:

- Interview (t = 5.89)
- Choose the appropriate dress for an interview (t = 4.32)
- Search for a job (t = 3.30)
- Improve their soft skills (t = 7.25)
- Correctly complete a paper job application (t = 3.95)
- Correctly complete an online job application (t = 3.48)
- Write/revise their resumes (t = 5.26)

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

More than a month after participating in the program, participants continued to use the information and skills gained from the program. Based on results from the delayed post-assessment (n = 93), many of the participants reported the following change in behavior:

- Revised their resumes created in the program to make them more appealing to different positions (75%)

- Used their resume to obtain employment (71%)
- Correctly completed a job application (85%)
- Correctly completed an online job application (75%)
- Used the skills gained from the program to answer questions appropriately in face-to-face interviews (83%)
- Used the skills gained from the program to select the appropriate dress for an interview (85%)

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

Although approximately 1,411 individuals benefitted directly from the program, the broader public also benefits from the program outputs as follows:

- Increasing individuals' success at obtaining employment reduces the mental and financial stress and strain placed on all family members.
- Increasing the number of job applications submitted helps employers match individuals to the job and organization more effectively.
- Increasing the number of jobs in communities contributes to communities' social and economic well-being.
- Identifying and obtaining employment can save the state millions in tax revenues and social service expenses.

Successful Aging Conference

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002380



Successful Aging Initiative Conference (ANNUAL)

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

The issue of aging is critical throughout the United States because the number of individuals 65 years and older is projected to double by 2040. The number of individuals 85 years and older will nearly quadruple between 2000 and 2040. For the first time in history, people who are 65 years and older will outnumber children under age five. Societal aging presents significant challenges for families and the health care system, the economic system, the job market, and nearly all aspects of society. The goal of this conference is to help seniors "age in place", and live healthier and more productive lives in their own homes.

The target audience for this program is limited resource older adults. Of the 2143 individuals who participated in this program, 100% were from urban areas in the state. Demographics collected for 2,143 participants indicated that 100% of the participants were adults. A little more than two-thirds (68%) were females. The majority of participants were Black (72%). Whites made up 25% of the participants and all other races made up approximately 3%. An additional 56 participants (2.5%) indicated being of Hispanic origin.

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

The major activities were six conferences held throughout the state by county agents through a series of presentations that addressed various community needs. Conference agendas included e-waste collections, drug takeback collections, container garden demonstrations, food distributions, tv interviews, radio interviews, social media posts, workbooks/activity books, newsletter articles, flyers, a resource expo, and newspaper articles. A series of presentations were used to help accomplish the program's goals and objectives. Results from respondents to conferences' surveys (n = 186) indicated the following:

- 84% of participants indicated that they could use the provided information to address some of their everyday issues and concerns.

- 69% of participants reported an increase in knowledge of available resources for older adults
- 76% of participants reported an increase in knowledge of fraud and scams
- 63% of participants reported an increase in knowledge of estate planning
- 78% of participants indicated using the information to make informed decisions.

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

- Access to printed cognitive activities and fact sheets help older adults with memory and understanding of how to deal with age-related issues.
- Access to resource items helps older adults maintain personal safety and independence.
- Information provided increases older adults' understanding of the availability of resources and how to obtain them.
- Information provided is used to make informed decisions regarding money, protection, healthcare, retirement, and other issues.
- Increased understanding of fraud and scams increases the ability to protect their identity.
- Reduced chances of falling.
- Increased ability to combat loneliness and isolation among older adults helps prevent mental issues and death.

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

Although approximately 2,143 individuals benefitted directly from the program, the broader public also benefits from the program outputs in the following ways:

- Increasing older adults' abilities to dispose of unused medication helps to reduce the chances that the unused drugs might be misused by youth or other individuals.
- Reducing the chances of falls among older adults reduces the financial and emotional stress and strain on family, friends, and community members.
- Reducing the number of older individuals losing millions of dollars to scams reduces the financial burden on them, family members, friends, and community members. Helping older adults avoid scams undoubtedly will help improve the overall financial status of individuals and their family members. Still, it will also help prevent stress-related health issues, leading to healthier families and communities.
- Combating loneliness and isolation among older adults improves their mental health, indirectly reducing emotional and financial stress on families, friends, communities, and healthcare systems.

Alabama 4-H Natural Resources and Environmental Education

Project Director

Mary Gregg

Organization

Auburn University

Accession Number

7002231



4-H Natural Resources and Environmental Education, Annual

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

Alabamians should recognize the value of our natural resources and protect them accordingly. Unfortunately, they often place a very low priority on environmental protection. Environmental illiteracy and decreased time spent outdoors contribute to a lack of knowledge about our natural resources and the role of various stakeholders. As such we are faced with an increasing disconnect from the natural world and a decline in informed public support for management and conservation of state resources. We must demonstrate our commitment to growing experienced outdoorsmen and future stewards.

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 addressed the need for increased environmental literacy, informed citizens, and future stewards of our natural resources by building capacity of ACES personnel and partners and providing opportunities for Alabama youth to connect to the outdoors and learn how to manage resources. By working with internal and external partners in urban and rural communities across the state, our programmatic efforts engaged 35,403 youth in forestry and wildlife, 17,280 in outdoor recreation, 13,137 in gardening, 6,481 in citizen science, and 11,904 in 4-H Science School residential environmental education and animal outreach. Capacity building opportunities included Purple Martin Project training (38 participants), Junior Naturalist Program training (18 participants), Project WILD educator certification workshops (99 participants), Sportfishing fishing education instructor certification workshop (6 participants), Entomology workshop (7 participants), Alabama Water Watch bacteriological/stream biomonitoring/Alabama rivers educator workshops (29 participants), Alabama Water Watch NOAA Bays and Watershed Education Training (19 participants), and 5 educational trainings for the Wildlife Habitat Education Program (23 participants), and 2 educational trainings for the Alabama Forestry Program (15 participants). In addition RiverKids paddling education instructors completed CPR, Paddlesports Safety, and Wilderness and Remote First Aid certification training as part of their continuing education requirements (12 participants), and paddling education volunteer assistants completed CPR, Paddlesports Safety, and paddling education training (4 participants).

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

Alabama adults and youth benefited from 4-H Natural Resources and Environmental Education program activities by becoming empowered to act as local stewards by gaining knowledge, certifications, and developing abilities to teach others; experiencing Alabama public lands and waters; partnering with our organization and accessing technical expertise and resources; and generating interest in natural resources related careers. The internal and external Project WILD educators that we certified conducted 250 programs across the state of Alabama reaching over 5,500 participants. We also experienced a 7% increase in adult leaders in paddling education, who led youth to 14 different bodies of public water across the state. There was a 20% increase in youth participants who paddled 21% more miles of freshwater than the previous year. Many cited “safe kayaking”, “water safety”, “being safe in water”, and “how to avoid obstacles”, and “working as a team keeps a lot of people safe” as the most important things they learned. The 4-H Sportfishing program afforded 81% more youth with casting, fishing, and aquatic resources education classes, while adding 6 new certified fishing education instructors. The 48 new Alabama Water Watch educators, along with existing ones, helped students across the state to conduct water monitoring of local water bodies and submit 62 water data records. After participating in our aquatic education programs, most youth expressed an interest in natural resource related careers, knew how to be a steward of the environment, and felt comfortable in and around water. All Sportfishing participants know the age at which an Alabama fishing license is required and that you should not be right next to someone when casting, 90% know that it is not okay to let a fish flop around on the ground, 80% know appropriate bait types and that bigger fish need bigger hooks. Most high school (93%) and elementary (84%) students involved in pathogen pollution training indicated that they could play a role in protecting local waters (nearly 20% increase) and those who now know how to give a presentation about a local body of water increased by 39%. The Wildlife Habitat Education Program (WHEP) and Alabama 4-H Forestry Program gained new county participation in training and programming this year from Jackson, Barbour, Russell, Dale, and Bibb counties. Youth program participants were qualified to compete at the state level and demonstrate their ecological and management expertise, including developing wildlife habitat management plans for designated sites (58 participants). The Walker County wildlife club represented Alabama at the National WHEP competition, earning the fourth-place title. The new Purple Martin Project initiative expanded on our previous work with wildlife habitat and gardening, helping our audience to link wildlife and agriculture in their own backyards. Nearly 50 youth received gourd seeds through 4-H Grows to grow gourds and construct into birdhouses for purple martin birds. Our 4-H Science School at the 4-H Center served many Alabama youth and adults onsite and off. They welcomed 63% more students from Alabama schools for residential learning, provided animal outreach to 45% more individuals, and served 15% more youth at 9 sessions of summer camp than the previous club year. Grant funds enabled kayaking as a first-time program offering for youth. In addition to training and program opportunities, our target audience received equipment and supplies to facilitate their delivery of local programming. Examples are as follows. Educators who completed the Alabama Water Watch NOAA Bays and Watershed Education training received over \$11k worth of monitoring supplies and materials to implement pathogen pollution mitigation work with youth in 8 coastal counties. Educators who became certified fishing education

instructors received Alabama aquatic organism guidebooks, 50 fishing rods and reels, and 6 fish casting activity sets. Replacement kits for conducting bacteriological and biomonitoring programs were distributed to 15 educators across the state.

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

We partnered with public and private entities for project activities which provides exposure to 4-H, connects participants to community, regional, and state points of interest, and builds rapport. These include the NOAA Marine Debris Education Program, Association of Fish and Wildlife Agencies, ADCNR Wildlife and Freshwater Fisheries Division, Alabama Wildlife Federation, Alabama Wildlife Center, E.O. Wilson Nature Adventure Center, Lineville City Park, E.T. Sims Recreation Center, Tyson Farm, and Terrapin Creek Outfitters. The 4-H Natural Resources and Environmental Education programs enabled youth to have skills to enter careers and the workforce such as critical thinking, teamwork, species identification, planning and management, and citizen science. They have the awareness necessary to protect and manage local resources in our state e.g., Nine high school students participated in a project forum at Blakely State Park where they shared research posters about pathogen pollution. We have developed youth and adults who know how to provide habitat that attracts native species (as demonstrated through Sportfishing, WHEP, Purple Martin Project, etc.). Further, we have helped youth develop the confidence that they can teach important skills and practices to others. For instance, 96% of youth paddlers are confident that they can help teach someone else to kayak (26% increase), and 90% of youth anglers are confident they can help teach others how to fish (20% increase). The public benefits from prevented drownings and water accidents because of safe recreation. Individuals who act ethically and responsibly with state's aquatic resources as demonstrated by handling fish, understanding that their actions affect downstream health, and refraining from introducing non-native invasive species to the environment. Most students (86%) now know how to help clean up or take care of a local stream, river, or beach; as well as tell others about the ways they can protect a local body of water (88%). Our youth are contributing to citizen science and providing data for important decision making concerning human health and the environment. Not only do they know how to identify native species, measure the health of a waterway, and write management plans- most of them (88%) reported that they could create science questions that they could answer by collecting data (30% increase).

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.

Climate and weather conditions were not always conducive to programming. Alabama's drought and flood conditions affected ability to utilize waterways for program activities and events. COVID19 continued to have some impacts on our abilities to reach youth and educators through in-person programming. Professional development opportunities were provided for ACES personnel and partners. In turn, the adult leaders have transferred knowledge and skills to their communities. RiverKids Instructors participated in risk management certifications in CPR, Wilderness and Remote First Aid Training, and Paddlesports Safety. In the next reporting period, program activities will continue as planned. New funding opportunities are being sought. Alabama native plants and climate change are being explored as areas of focus. Extension publications include Exploring Pathogens in Our Water curriculum and the Alabama Wildlife Habitat Education Program (WHEP) state manual. In addition Growing Birdhouse Gourds Journal A Closer Look at Lepidoptera Turning Gourds into Purple Martin Houses How to Build and Erect a Purple Martin Nesting Pole Food Chains & Food Web Activities/Background Food Chains & Food Web Cards What's the Attraction: Insects and Pheromones Insects and Their Table Manners: Insect Mouth Parts Bats and Echolocation Activity/Background

Risk and Protection in the Context of Peer Stress: Child and Parent Responses

Project Director
Stephen Erath
Organization
Auburn University
Accession Number
1021451



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

Peer stressors are major contributors to the mental health challenges of childhood and adolescence. This project examines youth and parent responses to youths' peer stress experiences, such as peer rejection and victimization.

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 analyzed data and published manuscripts, submitted a National Science Foundation grant proposal, and applied for IRB approval for a study protocol.

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

Erath, S. A., & Pettit, G. S. (2021). Coping with relationship stress in adolescence: A decade in review. *Journal of Research on Adolescence*, 31, 1047-1067. <https://doi.org/10.1111/jora.12603>

McWood, L. M., Erath, S. A., Pettit, G. S., Bates, J. E., Dodge, K. A., & Lansford, J.Æ. (2021). Organized activity involvement predicts internalizing and externalizing problems in adolescence. *Journal of Youth and Adolescence*, 50, 2181-2193. <https://doi.org/10.1007/s10964-021-01491-3>

Troop-Gordon, W., Erath, S.A. (2022). School Social Relations, Self-Regulation, and Social Decision-Making. In: van Lier, P.A., Deater-Deckard, K. (Eds.), *Biosocial Interplay During Elementary School*. Springer. https://doi.org/10.1007/978-3-031-07109-6_7

Hinnant, J. B., Gillis, B. T., Erath, S. A., & El-Sheikh, M. (2022). Onset of substance use: Deviant peer, sex, and sympathetic nervous system predictors. *Development and Psychopathology*, 34, 1506-1515. <https://doi.org/10.1017/S0954579421000158>

McWood, L. M., Frosch, C. A., Garrison, C. M. W., Erath, S. A., & Troop-Gordon, W. (in press). "But there's only so much you can do . . ." Parent support-giving within the context of peer victimization. *Journal of Early Adolescence*. <https://doi.org/10.1177/02724316221105587>

McWood, L. M., Erath, S. A., & El-Sheikh, M. (in press). Longitudinal associations between coping and peer victimization: Moderation by gender and initial peer victimization. *Social Development*. <https://doi.org/10.1111/sode.12623>

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

To date, results have been disseminated to the scientific community. Following further progress on the project, results will be shared with the broader public.

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

The project continues to generate information for the scientific community and provide training opportunities for undergraduate and graduate students.

Critical Issue

Food Systems and Food Safety

Developing and Implementing Strategies to Minimize Food Safety Risks for Fresh Produce Production in Alabama

Project Director

Camila Rodrigues



Developing and Implementing Strategies to Minimize Food Safety Risks for Fresh Produce Production in Alabama

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

In the past few years, the rise in the number of foodborne outbreaks linked to fresh produce in the U.S. highlights the urgency to improve food safety practices in the food supply chain as a way to prevent and minimize future outbreaks. Several factors can contribute to fresh produce contamination at the farm level, including water, soil, animals, workers, and other agricultural practices. Since farms are complex systems, it is important to understand some of the specific aspects that can implicate the safety of fresh produce in order to implement new strategies to minimize the risks. Thus, new research is essential to identify critical points of contamination and understand how microorganisms behave in the environment. This way, growers can implement risk mitigation strategies based on new findings.

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.

Activities outlined in this project are aimed to generate information to educate fresh produce growers and increase the adoption of food safety practices on their operation. In 2022, a total of 15 food safety training and events have been delivered (both virtual and in person) to fresh produce growers in Alabama and other states to capacitate individuals on farm good agricultural practices and to deliver targeted educational training, including new extension programs. In particular, the AgWater Safety Program was launched on July 2022 to provide free microbial water testing and technical support to Alabama growers through a project funded by the Alabama Department of Agriculture and Industries. So far, the program has directly benefitted 20 growers in Alabama that are participating in the program. Results from research projects have been included during training and events to assist growers with novel information regarding food safety practices and contamination risks.

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

Activities from this project directly benefit fresh produce growers in Alabama and other neighbor states, members of the Alabama Fruit and Vegetable Growers Association, the fresh produce industry, stakeholders, extension educators, and the general public.

Though activities generated from this project, including scientific peer-review publications, extension publications, webinars, and talks at conferences, the target audience can be better educated in regards to food safety practices and learn how to implement risk-mitigation strategies to reduce the risks of produce contamination and further foodborne illnesses.

Primary activities related to project goals:

1. To investigate and understand the potential risks of fresh produce contamination in the field.

Field data collection have started in 2021 to understand the risks associated with produce contamination via agricultural water. Preliminary results indicated that microbial contamination represent a food safety risk during the growing season, especially during the summer. In addition, results also demonstrated that *Cyclospora cayentanensis* might represent a risk to produce contamination since positive samples were found in water sources close to produce growing areas.

2. To develop and implement post-harvest sanitation practices to reduce risks of cross-contamination during handling, washing, and processing of fresh produce.

Research projects have been conducted to evaluate alternative sanitizer options for the post-harvest washing of different varieties of lettuce. Results demonstrated that essential oils (winter savory and oregano essential oils) can be a suitable alternative to commonly used chemical sanitizers. More research is necessary to understand economics and applicability of alternative sanitizer options.

3. To evaluate and develop alternative strategies for minimizing microbial contamination for fresh produce production in soilless systems.

Research and extension projects related to indoor agriculture have been conducted to implement new strategies to minimize microbial risks and to capacitate growers and educators on food safety practices for this target audience. Preliminary results demonstrated that the use of a bacteriophage, a biological control, can be a suitable alternative to control foodborne pathogens in water recirculating systems (hydroponic and aquaponic). Also, a new extension and research project have been funded by NIFA to support the development of a new food safety curricula for indoor agriculture. Outcomes from these projects will help hydroponic and aquaponic growers to better navigate through the challenges of implementing food safety practices on their operation and minimizing the risks of produce contamination.

List of peer-review research publications in 2022:

1. Townsend, A., Strawn, L.K., Chapman, B.J., Rodrigues, C., and Dunn, L.L. Adenosine Triphosphate (ATP) Bioluminescence is a Poor Indicator of *Listeria* spp. Presence in Distribution Centers Handling Fresh Produce. *Food Protect Trends*. 2022, 43:1, 33-39.
2. Pizzo, J.S., Visentainer, J.V., da Silva, A.L.B.R., Rodrigues, C. Application of essential oils as sanitizer alternatives on the postharvest washing of fresh produce. *Food Chemistry*. Dec, 2022, 407, 135101.
3. da Silva, A.L.B.R., Rodrigues, C., Dunn, L., Cavender, G., Coolong, T. Fertilizer Nitrogen Application for Short-Day Onion Production: From Field to Table. *Horticulture*. 2022, 8(9), 847.
1. Dunn, L.L., Sharma, V., Chapin, T.K., Friedrich, L.M., Colleen, C.L., Rodrigues, C., Jay-Russell, M., Schneider, K.R., and Danyluk, M. The prevalence and concentration of *Salmonella enterica* in poultry litter in the southern United States. *PLOS One*. 2022, 17(5): e0268231.

List of peer-review extension publications in 2022:

1. Blanchard, C. and Rodrigues, C. Produce Safety for Greenhouse Vegetable Production. Alabama Cooperative Extension System, 2022, ANR-2951.
2. Dawson, J., Chaverest, E., Hall, J., Mitchell, B., Rodrigues, C., and Woods, K. Water Sampling Facilitator Guide. National Food Safety Clearinghouse at the University of Vermont, 2022.
3. Dawson, J., Chaverest, E., Hall, J., Mitchell, B., Rodrigues, C., and Woods, K. Water Sampling Factsheet. National Food Safety Clearinghouse at the University of Vermont, 2022.
4. Niyigena, V., Beachem, D., Daniel, D., Rodrigues, C., and Woods, K. Rotational Grazing Facilitator Guide. National Food Safety Clearinghouse at the University of Vermont, 2022.
5. Niyigena, V., Beachem, D., Daniel, D., Rodrigues, C., and Woods, K. Rotational Grazing Factsheet. National Food Safety Clearinghouse at the University of Vermont, 2022.
6. Mitchell, B., Catalena, R., Chaverest, E., Rodrigues, C., and Woods, K. Field Mapping Factsheet. National Food Safety Clearinghouse at the University of Vermont, 2022.
7. Daniel, D., Gamble, A., Catalena, R., Rodrigues, C., and Woods, K. Cover Crops and Vegetative Buffers Factsheet. National Food Safety Clearinghouse at the University of Vermont, 2022.
8. Woods, K., Daniel, D., Gamble, A., Catalena, R., and Rodrigues, C. Cover Crops and Vegetative Buffers Facilitator Guide. National Food Safety Clearinghouse at the University of Vermont, 2022.
9. Rodrigues, C. & Woods, K. Food Recalls and Foodborne Outbreaks: What's the Difference? Alabama Cooperative Extension System, 2022, FCS-2703.
10. Rodrigues, C. Sampling and Shipping Instructions for Microbial Analysis of Agricultural Water. Alabama Cooperative Extension System, 2022, ANR-2860.
11. Woods, K., Rodrigues, C., Brannon, B., Fuller, O., Schavey, E., and Tucker, C. Step-by-Step Guide to Small Farm Irrigation. Alabama Cooperative Extension System, 2022, ANR-2860.

Other extension publications in 2022:

1. Woods, K. and Rodrigues, C. Pros and Cons of Controlled Environment Agriculture. *Specialty Crop Industry Magazine*, December 2022, p.14-15.

2. Rodrigues, C. Food Recalls vs. Outbreaks: What Growers Need to Know. Specialty Crop Industry Magazine, August 2022, p.20-21.

4. Woods, K. and Rodrigues, C. Food Safety Certification for Specialty Crops Program Helps Offset Costs for Growers. Alabama Cooperative Extension System. Blog, 2022.

5. Landim, F., da Silva, A., Rodrigues, C. Planting Broccoli in Alabama. Alabama Cooperative Extension System. Blog, 2022.

8. Woods, K. & Rodrigues, C. Senior Farmers Market Nutrition Program: A Win-Win For Growers and Seniors. Alabama Growers Permit. Alabama Cooperative Extension System. Blog, 2022.

9. Woods, K. & Rodrigues, C. Alabama Growers Permit. Alabama Cooperative Extension System. Blog, 2022. .

10. Kemble, J. et al. SE Vegetable Crop Handbook, 2022, p. 375.

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

Results and outcomes from this project benefitted not only the target audience (growers and industry) but also the general public on understanding the importance of food safety practices throughout the food supply chain. Information generated from this project was disseminated through extension and peer-review scientific publications, conference presentations, workshops, training, events, and radio and internet interviews.

Extension Programs developed in 2022:

1. AgWater Safety Program - Alabama Cooperative Extension System funded by the Alabama Department of Agriculture and Industries.

Radio and Interviews conducted in 2022:

1. Rodrigues, C. Improving Food Safety And Quality With Horticulturist Camila Rodrigues. Finding Genius Podcast, November 2022.

2. Rodrigues, C. Season 1 Episode 4 – Water Quality. Farming Basics Podcast, August 2022.

3. Rodrigues, C. The difference between food recalls and foodborne outbreaks. TV Interview to WSFA 12 News. August 2022.

Workshop, training and events conducted in 2022:

1. Rodrigues, Dunn, L., C., Woods, D., Mitchell, B., Hamilton, A. 2023. Produce Safety Alliance (PSA) Growers Training, Savannah, GA. Trainer (35 participants).

2. Rodrigues, C. 2022. The benefits of balancing food safety and conservation practices. Southeast Regional Fruit & Vegetable Conference, Savannah, GA. Speaker (17 participants).

3. Rodrigues, C., Daniluk, M., Schneider, K., Strawn, L., Hamilton, A. 2022. Packinghouse HACCP Training, Virtual, Trainer (23 participants)

4. Rodrigues C., et al. 2022. Cleaning and Sanitizing Workshop, Clanton, AL. Event organizer and speaker (19 participants).

5. Rodrigues, C and Hall, J. 2022. Fall Canning Workshop. Speaker (29 participants).

6. Rodrigues, C. 2022. Food Safety and Water Quality, Fruit and Vegetable Field Day, Clanton, AL. Invited Speaker (46 participants).

7. Rodrigues, C. 2022. Food Safety and Buying Local, Restaurant and Farmer Networking Event hosted by Sweet Grown Alabama, Huntsville, AL. Invited Speaker (16 participants).

8. Rodrigues, C. 2022. BDA Field Day: Food Safety Practices for Produce Growers, a Focus on Conservation Practices, Uniontown, AL. Invited Speaker (6 participants).

9. Rodrigues, C. 2022. Food Safety and Water Quality for Blueberry Growers, Clanton, AL. Invited speaker (12 participants).

10. Rodrigues, C. 2022. Food Safety for Aquaponics, Auburn, AL, Invited Speaker (35 participants).

11. Rodrigues, C. and Chevez, Z. 2022. Vegetable Crops Field Day, E.V. Smith Research Center, Auburn, AL (80 participants).
12. Rodrigues, C., Woods, K., Catalena, R., Brannon, B., Kelly, N. 2022. Advanced GAP Training, Virtual, Trainer (15 participants).
13. Rodrigues, C., Woods, K., Catalena, R., Kelley, J. 2022. Beginning GAP Training, Virtual, Trainer (6 participants).
14. Rodrigues, C., Woods, K., Brannon, B., Mitchell, B., Strawn, L. 2022. Produce Safety Alliance (PSA) Growers Training, Duffield, VA (20 participants).
15. Rodrigues, C., Woods, K., Daniluk, M., Schneider, K. 2022. Packinghouse HACCP Training, Virtual, Trainer (20 participants).
16. Rodrigues, C., Dunn, L., Woods, K., Bardsley, C. 2022. Produce Safety Alliance (PSA) Growers Training, Savannah, GA. Trainer (30 participants).

Presentations conducted in 2022:

1. Rodrigues, C. 2022. Commercial Horticulture Webinar Series, Online. Agricultural Water Update. Invited Speaker (Over 150 Facebook views).
2. Rodrigues, C. 2022. Water Quality and Food Safety at Fruit School Webinar, Blueberry Production, Online. Invited speaker (over 10 participants on zoom – over 35 Facebook views)
3. Rodrigues, C. 2022 – Commercial Horticulture Webinar Series, Online. Basics of Cleaning and Sanitizing. Invited speaker (Over 10 participants on zoom – over 40 Facebook views).

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.

Abstracts presented at professional conferences:

1. Hofstetter, J., Kahler, A., Peterson, A., Richins, T., Jacobson, D., Barratt, J., da Silva, A.L.B.R., Rodrigues, C., Qvarnstrom, Y., Mattioli, M. Evaluation of Prevalence and Methods of Detection of *Cylocospora cayetanensis* in Irrigation Water in the United States. IAFP Annual Meeting, Pittsburgh, PA, 2022.
2. Woods, K., Rodrigues, C., Williams, A., et al. Experiential learning opportunities for limited resource growers through mobile farm innovation in Mississippi, Alabama, and Georgia. National FSOP Meeting, Orlando, FL, 2022.
3. Rodrigues, C., Woods, K., Dunn, L. A Survey on Growers' Awareness Related to On-Farm Food Safety and Conservation Practices in the Southeastern United States. SR-ASHS Meeting, New Orleans, LA, 2022.
4. Fuller, O., Abbate, A., Rodrigues, C., Woods, K., Mujumdar, A. Pollinating the Field to Achieve the Yield; Program for Native Habitat On-Farm Assistance. SR-ASHS Meeting, New Orleans, LA, 2022.
5. Majumdar, A., Chambliss, A., Willis, H., Sikora, E., Kesheimer, K., Pickens, J., Vinson, E., Coneva, E., Kemble, J., Silva, A., Rodrigues, C., Han, D., Prasad, R., Gamble, A., Li, S., Rabinowitz, A., Jacobi, J., Conner, K., Thomas, S., Ulmer, M., and Chaves-Cordoba, B. How Alabama Extension Commercial Horticulture Program Team utilized social media and evaluation metrics for virtual event planning through the COVID-19 pandemic. SR-ASHS Meeting, New Orleans, LA, 2022.

Project Director

Jessica Starkey

Organization

Auburn University

Accession Number

7001904



NC1184: Molecular Mechanisms Regulating Skeletal Muscle Growth and Differentiation

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

Meat, derived from skeletal muscle, is one of the most economically important outputs of animal agriculture. Rapid, efficient deposition of lean muscle tissue is essential to economical production of high-quality meat which is critical to both the economic success of producers and the health of consumers. Development of successful strategies to increase efficiency of muscle production requires increased understanding of the biological processes regulating differentiation and growth of muscle in meat animals. The goal of this multi-state, multidisciplinary, basic research project is to utilize these tools to elucidate molecular and cellular processes that regulate differentiation and growth of skeletal muscle; thereby, providing the basic knowledge necessary to increase the efficiency of lean meat production in meat-producing animals.

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

We have utilized both in vitro and in vivo models and focused on exploring the impact of various nutritional factors (vitamins, minerals, amino acids, fatty acids, etc.) and management (including egg incubation) strategies on skeletal muscle development and growth in poultry and other meat-animal species. Investigating the impact of different feeding and management (including egg incubation) strategies on skeletal muscle satellite cell activity both in vitro and in vivo has contributed to the overall knowledge of the molecular mechanisms regulating skeletal muscle growth. We have made progress toward project objectives 1, 2, and 3 throughout the project reporting period through collection and analysis of muscle samples that allow us to determine the impact of various feeding and management strategies. Overall, our work has and will continue to further enhance the ability of animal scientists to continue to make improvements in the efficiency of lean muscle accretion in poultry and other meat-animal species.

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

1. Commercial meat animal and poultry producers benefit from the project's activities by using our work to develop approaches to increase the efficiency of lean meat production as well as other researchers investigating skeletal muscle growth by increasing our knowledge of the cellular and molecular mechanisms regulating muscle growth in domestic meat animals and fish. Through presentations at scientific conferences and workshops as well as extension and outreach activities, information gained as a result of this project will be disseminated to the target audience which includes: poultry and animal scientists; poultry and livestock industry personnel; feed scientists and feed industry personnel; feed ingredient suppliers; animal nutritionists; animal health professionals; extension specialists and agents; governmental policy makers; university students; animal agriculture affiliates of the state of Alabama and the greater USA; international agriculturalists with interest in USA agriculture.

2. Products:

1. Theses/Dissertations

1. Brittany Wall. 2022. Assessment of early-stage thermal variation on embryonic mortality, hatchability, growth performance, and carcass characteristics of broiler chickens. Auburn University Thesis

2. Caroline Gregg. 2022. Role of muscle satellite cells in the broiler chicken wooden breast myopathy. Auburn University Thesis

3. Jorge Sandoval. 2022. Effect of different dietary protein sources on skeletal muscle growth characteristics and stem cell activity of young piglets. Auburn University Thesis.

4. Joshua Flees. 2022. Role of muscle stem cells in the Wooden Breast broiler myopathic meat quality defect. Auburn University Dissertation.

2. Peer-reviewed publications

1. Abascal-Ponciano, G.A., S.F. Leiva, J. J. Flees, L. P. Avila, **J. D. Starkey**, and C.W. Starkey. 2022. Dietary 25-hydroxyvitamin D3 supplementation modulates intestinal cytokines in young broiler chickens. *Front Vet Sci.* 9:947276. doi: 10.3389/fvets.2022.947276

2. Sandoval, J. L., D. E. Ventura, O. B. Fiallos, B. L. Anderson, J. C. Sparks, **J. D. Starkey**, C. W. Starkey. 2022. Efficacy and safety of a novel source of dietary 25-hydroxycholecalciferol in growing pigs. *J. Anim. Sci.* 100(9):skac260. doi: 10.1093/jas/skac260.

3. Keel, A.J., A. J. Calderon, O. J. Tejeda, **J. D. Starkey**, and C. W. Starkey. 2022. Dietary protein source and litter condition alter broiler chicken intestinal macrophage and mitotically active cell populations. *Front Vet Sci.* 9:894587. doi: 10.3389/fvets.2022.894587.

4. Avila, L. P., S. F. Leiva, G. A. Abascal-Ponciano, J. J. Flees, K. M. Sweeney, J. L. Wilson, K. J. Meloche, B. J. Turner, G. Litta, A. M. Waguespack-Levy, A. Pokoo-Aikins, C. W. Starkey, **J. D. Starkey**. 2022. Effect of combined maternal and post-hatch dietary 25-hydroxycholecalciferol supplementation on broiler chicken Pectoralis major muscle growth characteristics and satellite cell mitotic activity. *J Anim Sci.* 100(8):skac192. doi: 10.1093/jas/skac192.

5. Gregg, C. R., O. J. Tejeda, L. F. Spencer, A. J. Calderon, D. V. Bourassa, **J. D. Starkey**, C. W. Starkey. 2022. Impacts of increasing additions of choline chloride on growth performance and carcass characteristics of broiler chickens reared to 66 days of age. *Animals (Basel).* 12(14):1808. doi: 10.3390/ani12141808.

6. Sweeney, K. M., C. D. Aranibar, W. K. Kim, S. M. Williams, L. P. Avila, **J. D. Starkey**, C. W. Starkey, and J. L. Wilson. 2022. Impact of every-day versus skip-a-day feeding of broiler breeder pullets during rearing on body weight uniformity and reproductive performance. *Poult Sci.* 101(8):101959. doi: 10.1016/j.psj.2022.101959.

7. Flees, J.J., C. W. Starkey, and **J. D. Starkey**. 2022. Effect of different basal culture media and sera type combinations on primary broiler chicken muscle satellite cell heterogeneity during proliferation and differentiation. *Animals (Basel).* 12(11):1425. doi: 10.3390/ani12111425.

8. Leiva, S. F., L. P. Avila, G. A. Abascal-Ponciano, J. J. Flees, K. M. Sweeney, J. L. Wilson, **J. D. Starkey**, and C. W. Starkey. 2022. Combined maternal and post-hatch dietary supplementation of 25-hydroxycholecalciferol alters early post-hatch broiler chicken duodenal macrophage and crypt cell populations and their mitotic activity. *Front Vet Sci.* 9:882566. doi: 10.3389/fvets.2022.882566.

9. Avila, L. P., S. F. Leiva, G. A. Abascal-Ponciano, J. J. Flees, K. M. Sweeney, J. L. Wilson, B. J. Turner, G. Litta, A. M. Waguespack-Levy, A. Pokoo-Aikins, C. W. Starkey, **J. D. Starkey**. 2022. Combining maternal and post-hatch dietary 25-hydroxycholecalciferol supplementation on broiler chicken growth performance and carcass characteristics. *Poultry.* 1(2):111-124. doi: 10.3390/poultry1020010.

10. Gregg, C.R., O. J. Tejeda, L. F. Spencer, A. J. Calderon, D. V. Bourassa, **J. D. Starkey**, C. W. Starkey. 2022. Effect of dietary choline chloride supplementation on growth performance and carcass characteristics of broiler chickens reared to 32 days of age. *Poultry*. 1(2), 66-73. doi: 10.3390/poultry1020007.
11. Polese, C., Wachholz, L., Souza, C., Rohloff Junior, N., Tesser, G.L.S., Kolher, T.L., Kaufmann, C., Eyng, C., Starkey, J.D., Starkey, C.W., Nunes, R.V. 2022. Influence of light intensity, pre-harvest fasting and storage time on calcium, phosphorus, and alkaline phosphatase activity in serum and plasma of broilers. *Poultry Science Association Latin American Scientific Conference*. *Poult. Sci.* 101 (E-suppl.).
12. Andrade, T.S., Polese, C., Carvalho, M.B., Rohloff Junior, N., Souza, M.C.M., Pereira, M.F.C., Câmara, M.M.T., Datsch, L.I., Bebbler, B.A., Uhlein Junior, M.R., Toniazzi, G., Campos, F.P., Souza, C., Costa, A.P.C., Kohler, T. L., Sartor, H., Wachholz, L., Starkey, J.D., Eyng, C., Nunes, R.V. 2022. Influence of light intensity, blood fraction, fasting and storage time on energy pathway metabolites in broilers. *Poultry Science Association Latin American Scientific Conference*. *Poult. Sci.* 101 (E-suppl.).

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

Our project activities benefit the general public by contributing to the overall availability, affordability, and quality of their meat supply. As chicken is the most consumed meat by the US consumer, our specific efforts to improve the growth efficiency of meat chickens and eliminate the meat quality defect, Wooden Breast, from the meat supply has significant direct benefit the broader public.

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

Fourteen graduate research assistants, 8 undergraduate research assistants, and 7 visiting research scholars all received training in the various animal husbandry, sample collection, lab techniques, data analysis, and oral/poster presentation of data, both in-person and virtually. Students at all levels presented at local and international scientific conferences and symposia and interacted with other scientists and industry stakeholders. Results and data were presented at local, state, national, and international scientific conferences and industry stakeholder meetings. Results from our activities were published in peer-reviewed journals. During the upcoming project period, the role of incubation conditions in regulating muscle stem cell activity in meat chicken growth and product quality will be a major focus of our work toward achieving the major project goals.

Integrated systems genomics approaches to improve beef cattle production

Project Director

Wellison Jarles Da Silva Diniz

Organization

Auburn University

Accession Number

7001525



Integrated systems genomics approaches to improve beef cattle production

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

Fertility is a critical component of an efficient cow-calf enterprise and is affected by genetic and environmental factors, including nutrition. There is no accurate tool or biomarker available to early select heifers for high reproductive potential. This project approaches the fertility issue through multidisciplinary research studying genomic data from heifers that become pregnant and those that remain open. Additionally, we are investigating the effects of nutrition during pregnancy on the

productive potential of the offspring. We aim to find biomarkers predictive of the (re)productive potential of beef cattle so we can early identify and select the best animals, as well as design and implement nutritional strategies to improve production efficiency.

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

Major activities are described based on the proposed goals for this project as follows:

Goal 1 – Create a genomic database including genotypic and phenotypic information related to heifer performance and fertility traits.

We have collected data from 318 heifers at weaning, breeding season, or pregnancy check. From these animals, we collected white blood cells that are going to be used for RNA analysis (n = 589 samples), DNA genotyping (n = 318), and plasma analysis (n = 509). We will be continuing retrieving phenotypic data of these animals from the CattleMax database available from the Experiment Stations and in collaboration with the Alabama Beef Cattle Improvement Association (BCIA). These biological samples and phenotypes allowed us to select heifers to achieve goals 2 and 3, as described below.

Goal 2 – Identify biomarkers related to the reproductive potential and performance of heifers through genome-wide association, transcriptomic, proteomic, and metagenomic technologies.

3 – Integrate the genomic data generated in the project to develop a higher-order regulatory understanding of the basic mechanisms of heifer fertility.

Samples from Goal 1 were selected and used for RNA-Sequencing. Data analysis is underway.

We also retrieved RNA-Seq public data (n = 72 heifers/cows) and miRNA data (n = 17) of heifer fertility-related studies in beef cattle to perform systems genomics data analysis and genetic variant prediction. We have implemented a machine-learning model and identified nine candidate genes underlying cattle fertility. These candidates could predict pregnancy status at the time of embryo transfer. We are mining and integrating these data to identify related mutations associated with gene expression and cow fertility.

4 – Investigate the effects of heifer nutritional management in the (re)productive performance and potential long-term consequences on offspring development.

We have collected liver (n = 16) and muscle (n = 16) tissues of fetuses on day 83 of gestation from heifers fed diets to provide low or moderate average daily gain (0.28 or 0.79 kg/d, respectively). Total RNA has been isolated from these tissues and sent for mRNA and miRNA sequencing.

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

The targeted audience of the findings provided by this project includes beef cattle producers, undergraduate, and graduate students, and the livestock scientific community.

For beef cattle producers, we have published four extension publications made available online (see below). One undergraduate student was trained to perform laboratory analysis. One master's student and one Ph.D. student are being trained in genomics data analysis. To the scientific community, two talks were presented based on the findings of the current project at the ASAS annual meeting (Oklahoma) and the International Symposium on Selenium in Biology and Medicine (Hawaii). Furthermore, seven peer-reviewed manuscripts and nine conference proceedings were published.

Publications

Goals 2 and 3 – Type: *Journal article*

1. Banerjee P, Rodning SP, **Diniz WJS**, Dyce PW. (2022). Co-expression network and integrative analysis of metabolome and transcriptome uncovers biological pathways for fertility in beef heifers. *Metabolites*. DOI: 10.3390/metabo12080708.
2. **Diniz WJS**, Banerjee P, Rodning SP, Dyce PW. (2022). Machine learning-based co-expression network analysis unravels potential fertility-related genes in beef cows. *animals*. DOI: 10.3390/ani12192715.

Type: *Conference Proceedings*

1. **Diniz WJS**, Banerjee P, Rodning SP, Dyce PW. (2022). PSVIII-B-13 - Machine Learning-based Co-expression Network Analysis Unravels Fertility-related Genes in Beef Cattle. In: 2022 ASAS-CSA Annual meeting - Triennial Growth Symposium. OK, Oklahoma. DOI: 10.1093/jas/skac247.573.
2. Banerjee P, Rodning SP, **Diniz WJS**, Dyce PW. (2022). PSXIII-B-12 - Identifying Gene and Metabolite Signature Patterns by Mining Co-expression Networks for Fertility in Beef Heifers. In: 2022 ASAS-CSA Annual meeting - Triennial Growth Symposium. OK, Oklahoma. DOI: 10.1093/jas/skac247.595.

Goal 4 -

Type: *Journal article*

1. Reynolds LP, **Diniz WJS**, Crouse MS, Caton JS, Dahlen CR, Borowicz PP, Ward AK. (2022). Maternal nutrition and developmental programming of offspring. Reproduction, Fertility and Development. DOI: 10.1071/RD22234.
2. **Diniz WJS**, Crouse MS, Caton JS, Claycombe-Larson KJ, Lindholm-Perry AK, Reynolds LP, Dahlen CR, Borowicz PP, Ward AK. (2022). DNA methylation dataset of bovine embryonic fibroblast cells. Data In Brief. DOI: 10.1016/j.dib.2022.108074.
3. **Diniz WJS**, Ward AK, Du M. (2022). Editorial: Genomic basis of developmental programming in livestock: insights into nutrition, health, and production. Frontiers in Genetics. DOI: 10.3389/fgene.2022.861740.
4. Crouse MS, Caton JS, Claycombe-Larson KJ, **Diniz WJS**, Lindholm-Perry AK, Reynolds LP, Dahlen CR, Borowicz PP, Ward AK. (2022). Epigenetic modifier supplementation improves mitochondrial respiration and growth rates and alters DNA methylation of bovine embryonic fibroblast cells cultured in divergent energy supply. Frontiers in Genetics. DOI: 10.3389/fgene.2022.812764.
5. **Diniz WJS**, Reynolds LP, Ward AK, Borowicz PP, Sedivec KK, McCarthy KL, Kassetas CJ, Baumgaertner F, Kirsch JD, Dorsam ST, Neville TL, Forcherio JC, Scott TT, Caton JS, Dahlen CR. (2022). Untangling the placentome gene network of beef heifers in early gestation. Genomics. DOI: 10.1016/j.ygeno.2022.110274.

Type: *Conference Proceedings*

1. **Diniz WJS**, Menezes ACB, McCarthy KL, Hall JA, Caton JS, Dahlen CR, Ward AK. (2022). 213 - From Conception to Birth: The Role of Minerals on Beef Cattle Fetal Programming. In: 2022 ASAS-CSA Annual meeting - Triennial Growth Symposium. OK, Oklahoma. DOI: 10.1093/jas/skac247.351.
2. Ruiz BJD, Dahlen CRR, Hurlbert JLL, [...], **Diniz WJS**, et al. (2022). PSV-B-17 - Effect of Dietary Supplementation with Vitamins/minerals And/or Energy on Fetoplacental Vascularity in Crossbred Angus Heifers. In: 2022 ASAS-CSA Annual meeting - Triennial Growth Symposium. OK, Oklahoma. DOI: 10.1093/jas/skac247.634.
3. Jurgens IM, Baumgaertner F, Underdahl SR, Hurlbert JL, [...], **Diniz WJS**, [...], Dahlen CR. (2022). PS-6 Nutrition During Early Pregnancy Impacts Offspring Ovarian Characteristics. DOI: 10.1093/jas/skac313.027.
4. Dahlen CR, Hurlbert JL, Baumgaertner F, [...], **Diniz WJS**, et al. (2022). Selenium Transport from Dam to Fetus: Movement and mechanisms. In: 2022 12th International Symposium on Selenium in Biology and Medicine. HI, Hawaii.

5. **Diniz WJS**, Bobe G., Klopffeststein j, et al. (2022). Maternal selenium supplementation during different trimesters of pregnancy: Effects on neonatal calve muscle transcriptome. In: 2022¹²th International Symposium on Selenium in Biology and Medicine. HI, Hawaii.

6. Hurberlt J, Baumgaertner F, Bochantin K, Menezes ACB, **Diniz WJS**, et al. (2022) 56 Vitamin and Mineral Supplementation Throughout Gestation Affects Liver Trace Mineral Status of Dam and Neonatal Calves but not Calf Morphometric Characteristics. In: 2022 ASAS Midwest Section Meeting. USA. DOI: 10.1093/jas/skac064.028.

Type: Extension Publication

1. Baumgaertner F, Menezes ACB, **Diniz WJS**, Hurlbert JL, Bochantin KA, Kirsch JD, Dorsam ST, Underdahl SR, Sedivec KK, Dahlen CR. (2022). Rate of gain during early gestation in beef heifers does not influence development, feed intake and behavior, puberty attainment, and concentrations of hormones and metabolites in female offspring. Available on: https://www.ndsu.edu/agriculture/sites/default/files/2022-09/as2066_0.pdf
2. Hurlbert JL, Baumgaertner F, Menezes ACB, Bochantin KA, **Diniz WJS**, Underdahl SR, Dorsam ST, Kirsch JD, Sedivec KK, Dahlen CR. (2022). Supplementing trace minerals to beef heifers during gestation: impacts on mineral status of the dam and neonate, postnatal performance and colostrum characteristics Available on: https://www.ndsu.edu/agriculture/sites/default/files/2022-09/as2066_0.pdf
3. Jurgens IM, Underdahl SR, Hurlbert JL, Bochantin KA, Sedivec KK, Kirsch JD, Dorsam ST, Menezes ACB, **Diniz WJS**, Ward AK, McCarthy KL, Caton JS, Dahlen CR. (2022). Nutrition during early pregnancy impacts offspring ovarian characteristics. Available on: https://www.ndsu.edu/agriculture/sites/default/files/2022-09/as2066_0.pdf
4. Dávila BJ, Dahlen CR, Hurlbert JL, Baumgaertner F, Bochantin KA, Menezes ACB, **Diniz WJS**, Underdahl SR, Kirsch JD, Sedivec KK, Borowicz PP, Cánovas S, Reynolds LP. (2022). Effect of supplementation with vitamins and minerals and/or rate of gain on placental vascular development of Angus heifers. Available on: https://www.ndsu.edu/agriculture/sites/default/files/2022-09/as2066_0.pdf

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

The publications derived from the current work are open, free, and public available for the community. Our findings provided a better understanding of the effect of maternal nutrition on fetal development. Likewise, we provided nine candidate biomarkers affecting fertility and discriminating between pregnant and open cows.

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.

For publications please refer to the “target audience” section

Improving the reproductive efficiency of cow-calf operations.

Project Director

Paul Dyce

Organization

Auburn University

Accession Number

7001621



Improving the reproductive efficiency of cow-calf operations.

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

The ability to select heifers as replacements with high reproductive potential is limited using traditional phenotypic parameters. This results in a significant proportion (5-25%) of heifers remaining open following their first breeding season and leads to inefficiencies within the cow-calf sector. We are investigating the use of molecular methods to differentiate between heifers with high and low reproductive potentials.

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 and previous years we have been bio-banking blood samples from beef heifers during different stages of development. The Angus-Simmental cross heifers are then put through an estrus synchronization and artificial insemination (AI) program and pregnancy checked. This allows us to separate the heifers into low-performing (not pregnant) and high-performing (pregnant by AI) groups for analysis. We have collected plasma and peripheral white blood cell (PWBC) samples from heifers at weaning, one month prior to-, and at AI. Previously, we have identified metabolites at different levels in the blood plasma of heifers at the time of AI with differing reproductive potentials. We have also found differentially expressed genes in the PWBC of heifers with differing reproductive potentials. This previous year we have utilized 135 heifers to identify groups with differing reproductive potentials. We integrated the metabolite and gene expression data to identify biological pathways and potential molecular targets for developing fertility detection assays. We found 8 unique potential targets in the pregnant group and 22 unique potential targets in the non-pregnant group. We are currently exploring the utility of using these targets to identify reproductive potential at the time of AI.

We are also investigating the possibility of molecular targets being present at the time of weaning. This would be more beneficial for heifer selection as it would allow the producer to limit resources used on heifers with low reproductive potentials. We have generated metabolomic profiles from low- and high-performing heifers and have identified 9 metabolites at different levels in the low- and high-performing heifers. We have also generated transcriptomes and found 92 differentially expressed genes. We are currently integrating these data sets to identify biological pathways effected and potential targets for developing identification assays.

In order to better understand the potential causes of sub-fertility in heifers we have also utilized pathway analysis on the data sets generated in the lab. Common pathways have been identified including, the immune system, regulation of the immune system, cytokine production, and regulation of cytokine production. We have initiated efforts to look at cytokine levels and regulation through the analysis of gene transcripts and proteins related to these pathways.

Finally, we completed an animal experiment where we put 40 heifers through an estrus synchronization and AI program. The 20 that bred first service were considered high-performing and we selected 8 and terminated their pregnancies. The remaining 20 were placed with a fertile bull for 90 days and pregnancy checked. Five remained open and were considered low-performers. The 13 animals were harvested and we collected samples including blood (for plasma and PWBC samples), ovary, granulosa cells, oocytes, and endometrium. We are currently generating metabolic profiles and transcriptomes to try to better understand the cause of fertility issues in beef heifers.

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

We have disseminated results from this project to both beef producers and the scientific community. We specifically reached out to beef producers through presentations at the following:

Alabama Beef Cattle Improvement Association (BCIA) annual meeting:

- Paul Dyce, Erin Mahoney. How can we apply BCIA Records to learn more? BCIA 2022 Annual Meeting. April 2nd, 2022. Montgomery, Alabama.
- Erin Mahoney, Paul Dyce. Using metabolomic profiles as a method to identify heifer fertility potential. BCIA 2022 Annual Meeting. April 2nd, 2022. Montgomery, Alabama.

Alabama Cattleman's Association Convention and Trade Show:

- Paul Dyce, Rachel Hollingsworth, Anna Holliman. Reproductive Research at Auburn University. ACA Convention & Trade Show. March 5th, 2022. Mobile, Alabama.

The scientific community has been targeted through presentations at scientific conferences::

- Priyanka Banerjee, Soren Rodning, Wellison Diniz, Paul Dyce. Identifying gene and metabolite signature patterns by mining co-expression networks for fertility in beef heifers. ASAS-CSAS Annual Meeting. January 26-30, 2022. Oklahoma City, Oklahoma.
- Wellison Diniz, Priyanka Banerjee, Soren Rodning, **Paul Dyce**. Machine learning-based co-expression network analysis unravels fertility-related genes in beef cattle. ASAS-CSAS Annual Meeting. January 26-30, 2022. Oklahoma City, Oklahoma.
- Erin Mahoney, Landon Marks, Soren Rodning, Josh Elmore, Kent Stanford, **Paul Dyce**. Free amino acids at weaning in the blood plasma of beef heifers. ASAS-CSAS-SSASAS Annual Meeting & Trade Show. January 25, 2022. Fort Worth, Texas.

We also produced the following MS graduate student thesis:

Mahoney, Erin (2022) Examining the ability of molecular methods to differentiate reproductive potentials in Bos taurus heifers. Master's Thesis

We disseminated results through publication of peer-reviewed manuscripts:

- Banerjee P, Rodning SP, Diniz WJS, Dyce PW (2022) Co-expression network and integrative analysis of metabolome and transcriptome uncovers biological pathways for fertility in beef heifers. *Metabolites*. 12(8):708. doi: 10.3390/metabo12080708
- Diniz WJS, Banerjee P, Rodning SP, Dyce PW (2022) Machine learning-based co-expression network analysis unravels potential fertility-related genes in beef cows. *Animals*. 12(19):2715. doi: 10.3390/ani12192715
- Liu W, Tan S, Wang YF, Zhang F, Feng Y, Ge W, Dyce PW, Reiter RJ, Shen W, Cheng S (2022) Melatonin promotes proliferation of primordial germ cell-like cells derived from porcine skin-derived stem cells. *Journal of Pineal Research*. doi: 10.1111/jpi.12833
- Sun JD, Sun Y, Qiao T, Zhang SE, Dyce PW, Geng YW, Wang P, Ge W, Shen W, Cheng SF (2022) Cryopreservation of porcine skin-derived stem cells using melatonin or trehalose maintains their ability to self-renew and differentiate. *Cryobiology*. 107:23-34. doi: 10.1016/j.cryobiol.2022.06.002.
- Yan HC, Sun Y, Zhang MY, Zhang SE, Sun JD, Dyce PW, Klinger FG, De Felici M, Shen W, Cheng SF (2022) YAP regulates porcine skin-derived stem cells self-renewal partly by repressing Wnt/ β -catenin signaling pathway. *Histochem Cell Biol*. 157(1):39-50. doi: 10.1007/s00418-021-02034-4.

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

The broader public has benefitted from our activities through us using presentation opportunities to inform the public of current methods being used in agriculture to promote sustainability. We use these opportunities to highlight "best practice" approaches to beef producers. This will ideally lead to improvements at the producer level thereby limiting resources needed for beef production. We have also generated training opportunities during this project including one postdoctoral researcher, and three MS graduate students.



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

Many communities suffer from food insecurity. This program addresses food deserts through the development of home and community gardens.

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 goal of GMGM is to teach adults how to start their own gardens and grow an extra row to share within the community. This program uses best management practices along with a volunteer component that assists with donations within the community. The end result brings fresh fruits and vegetables to our gardeners builds community engagement and encourages healthy eating. In conjunction with the Master Gardener program, GMGM donated 44,696 pounds (22.3 Tons) of produce. REAs recorded 10,108 direct contacts in 2022 with 26% related to grow more give more and 74% to Alabama Smart Yards.

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

This program offered 96 events statewide that were REA led. Master Gardener volunteers were an integral part of the program by maintaining 11 demonstration gardens. Overall there were 5,575 participants. With 4,332 indirect contacts and 2,947 app downloads. There were 11,498 pounds of produce donated directly from this program. With 4,369 transplants were donated to individuals and communities. Several programs were offered. Some events held were Veteran Gardening, Totally Tomato, Raised Beds, Small Space Gardening, fruit Tree pruning, Sensory Gardens, Edible Landscapes, Seed Starting Workshop, and basic vegetable gardening amongst many others. The average number events each person attended was 10.6. This means our learners keep coming back. Program participants reported an average program value of \$76.00 dollars per program with an average cost savings of 176 per program. Based on an retail average of \$2.00, the 2022 GMGM donations totaled \$22,996.00. This program is in collaboration with many other programs. Such as Extension Master Gardener, Commercial Horticulture, Extension Food Safety and SNAP-Ed Agents, 4-H and County Extension Coordinators.

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

96 programs were implemented in 66 zip codes. The community continues to see value in this program. In 2022, 4,369 transplants were shared throughout the state. Participants can register their garden to record donations. Recipes are shared to help gardeners make the most of their produce along with guides demonstrating how to properly care for their new plants. The return on investment was 44:1

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.

Number of Publications: Extension - 4 Research - Total (calculated) - 4



Meeting the Needs of the New Generation of Producers through the Alabama Beginning Farmer Program - Annual

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

Commercial specialty crop industry is worth \$161 million with \$103 million in value added agriculture in Alabama. Beginning farmers (<10 years farming) comprise of a significant part of the food system and food security in Alabama. As new clients, the beginning farms (2 to 5 acres) comprise of nearly 30 of commercial horticulture audience requiring direct training, consultation, and long-term support from Alabama Extension for sustaining their small farms across Alabama, including those in underserved communities. Alabama Extension Commercial Horticulture team along with five other Extension teams (home grounds/animal science/agronomy/agribusiness/food safety) forms the massive statewide 'knowledge infrastructure' to directly support beginning farmers and resource needs of other collaborators (e.g., NGOs) under FARMING BASICS as our brand.

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 2015, the Alabama Beginning Farmer program have been supported by 30+ grants from the USDA-NIFA BFRD, SARE Research & Education, SARE Professional Development, Extension IPM, Organic Transitions & OREI, ADAI Specialty Crops Block Grant Programs, and many more! Online long-term educational materials: Farming Basics is our brand! Farming Basics Online Course (Phase-1 has 1648 students enrolled, Phase-2 is under development). Farming Basics Phone App (Phase-2) is available as a critical tool - DIGITAL CONVERGENCE with all Team resources built-in. Farming Basics Podcast was developed and 10 episodes available online and via the app. Alabama Beginning Farmer Website (www.alabamabeginningfarmer.com) and Alabama IPM/Sustainable AGÆ-newsletter (3,300+ subscribers) are digital media projects are coordinated by Ann Chambliss (Program Assistant). The Farming Basics App also connects clients to all social media channels and YouTube playlist on the Internet resulting in large usage. COVID-19 Virtual Events: Virtual Farms Tours (2020-present), Q&A Fridays (2020 and 2021a discontinued in 2022 but recordings available to audience), Commercial Horticulture Webinar Series (2016 to present a longest running webinar series). Virtual and hybrid field events are being coordinated by Harli Willis (Program Assistant) for a large outreach.

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

The Alabama Beginning Farmer Program is slowly returning to field events and face-to-face consultations after a period of separation from audience during the Pandemic. Over 10 field HYBRID events were conducted that were attended by 273 attendees. Participation in grower conferences with presentations and exhibitions allowed direct contact with 190 additional clientele. Five inperson events were surveyed with a 41% response rate (n=48). Respondents owned 1 to 5 acres (organic or naturally grown) and up to 50 acres for conventional farms. Respondents reported 427 total vegetable acres. Nature of audience: New/Beginning farmersÆ 34% (Certified OrganicÆ 8%; Certified naturally GrownÆ 2%); Experienced producersÆ 31%; NRCS/FSA personnelÆ 17%; Market gardeners/urban farmsÆ 10%; Veteran farmersÆ 9%. Change in knowledge (based on pre/posttests): Improvement in knowledge of insect scouting methodsÆ 39%; Improvement in knowledge of temporary or permanent pest exclusion systemÆ 55%; Improvement in knowledge of biorational insecticidesÆ 35%; Improvement in knowledge about selective insecticides & tank-mixesÆ 24%; Improvement in knowledge about GAP/Food Safety/Water Quality IssuesÆ 29%. Adoption rates of specific practices: Overall IPM adoptionÆ 46 to 50%; Insect scouting techniquesÆ 32%; Trap cropping & sanitationÆ 23%; Pest exclusion tacticsÆ 21%; Biological/botanical insecticidesÆ 42%; Use of selective conventional insecticidesÆ 24%; Spider mite reduction practicesÆ 15%; Fertilizer recommendationsÆ 75%; Irrigation scheduling for vegetable cropsÆ 43%; High yielding vegetable cultivars = 36%; FungicidesÆ 50%; Food safety practicesÆ 57%. Use of Extension Resources: High Tunnel HandbookÆ 21%; SE Vegetable HandbookÆ 53%; Organic Veg. IPM Slide chartÆ 38%; Home Garden IPM GuideÆ 18%; Crucifer IPM GuideÆ 8%; Alabama IPM/Sustainable AGÆ-newsletterÆ 39%; Farming Basics AppÆ 38%; Alabama Virtual Farm Tours (2020 & 2021) = 38%; Commercial Horticulture Monthly Webinar SeriesÆ 33%; Q&A Friday Shows (2020 & 2021) = 22% Barriers to adoption: Lack of awareness; High input cost/Lack of capital; Low availability of insecticidal products Overall satisfaction from training eventsÆ 60 to 85% (averageÆ 76%) (But for question) Participant response to question "If there were NO training events or field demonstrations, what would happen?": Responses "I wouldn't

farm!"; "Go without knowledge"; "Farm would fail"; "Wouldn't know who to reach out to with questions."; "Far less productivity on my farm"; "Will have info void." Farming Basics Online Course The FARMING BASICS Online Course Part 1 has over 1,648 students enrolled with 25% completion rate and 95% satisfaction rating. Participants in the course come from over 20 states within USA and five other countries. The first-level course has 5 chapters and 27 learning modules or introductory topic areas. Adoption rate for information is 79%. Community colleges are utilizing this FREE COURSE in their ag training programs for CEUs for students and ag advisors. Open to everyone. Checkout the course at <https://aces.catalog.auburn.edu/courses/acesfarmingbasics01>. Please share out with others. Thanks to Alabama Extension Commercial Horticulture Team members for the content and participants for supporting the success of this endeavor!

Alabama IPM/Sustainable AG E-newsletter (<https://www.aces.edu/blog/topics/ipmfarming/alabama-ipm-sustainable-ag-newsletter/>): Commercial specialty crop industry is worth \$161 million with \$103 million in value added agriculture. Without research and educational support, yield losses and crop contamination on small farms can be as high as 55% in a very short time. In order to communicate pest migration and IPM updates, the Alabama IPM/Sustainable AG E-newsletter has been published and growing since 2010. It is published using MailChimp and archived on ACES.edu. This is a grant funded activity supported by USDA-NIFA SARE, BFRD, CPPM, and ADAI Specialty Crops Block Grants. Over 3,600 subscribers received 24 issues of this enewsletter (2 issues per month). Of the 70,561 emails sent in 2022, there were 19,709 unique opens suggesting 28% unique open rate (over 32,690 total opens). About 3,288 blog articles and event listings were accessed by subscribers that include 40% beginning farmers and 20% experienced producers among other client segments like gardeners (30%) and educators (10%). The e-newsletter archive (<https://www.aces.edu/blog/topics/ipm-farming/alabama-ipm-communicator-newsletterarchive/>) received 1,000 unique views. About 70% respondents surveyed using Qualtrics survey suggest that the newsletter articles aids in IPM decision-making and 70% agree that the information promotes sustainable agriculture. Over 50% respondents attended one or more COVID-19 virtual events done by the commercial horticulture team in 2020 and 2021. 94% respondents are satisfied with the quality of the newsletter. 13 respondents averaged 24% yield improvement and 8 cases of pesticide savings of \$6,455. Social Media Evaluations The Commercial horticulture team utilizes Facebook as the primary social media channel at the team level (<https://www.facebook.com/AlabamaExtensionCommercialHorticulture>). This activity is supported by grants from several agencies as social media-based learning and hybrid events have become critical to the team to reach new audience post-pandemic. The 'Alabama Extension Commercial Horticulture' Channel on Facebook has 2,275 subscribers along with 1,606 subscribers on the Alabama Vegetable IPM channel. The 'Alabama Farmer Connection' channel, a peer-to-peer learning group that was established in 2020 just as the pandemic hit, has grown to 2409 subscribers within a few years. The latter is a very popular network of small farmers across AL to exchange general farming ideas, advertise farm machinery and products for sale, farm services and meeting information, etc. All channels are moderated by Extension professionals on the team. The three Virtual Farm Tour recordings (Fish River Trees, Wallace State Ag Program, and Joy Haven Farm) received 34 Likes, 8 shares, 778 reach, 45 engagements, and 371 recording views via Facebook and 454 views via YouTube channel. The Commercial Horticulture Monthly Webinars and Special Events (e.g., Fruit School Series in March 2022, Vegetable School Series in April 2022) had 1,199 direct participants in 25 completed events. Overall, Facebook Insights indicated 186 likes, 87 shares, and 664 engagements for videos posted that are now publicly available without a login via the webpage below. The events had 8,887 reach and 3,846 recording views (61+ hours watch time) with 42 percent male and 58 percent female audience. All online events are archived at <https://www.aces.edu/blog/topics/crop-production/digital-resources-for-farmers/> for easy sharing and viewing (1,439 blog views in 2022). Data trends/outcomes: The calculated Percent Virality is 2% overall with 29% Engagement Rate and 16% Post Reach for webinars completed on the Facebook channel indicating increasing popularity of the digital events. From a sample of 183 participants (66% response rate), the estimated or potential impact of 8 webinars was \$135,767 minimum, based on audience feedback immediately after the events (i.e., impact of \$741 per participant). The estimated impact of the Vegetable School Webinars (6 events) was \$22,982 based on 97 responses (45% response rate) with 20 percent new audience; this was equivalent to an impact of \$237 per participant. Participants from USA, Pakistan, India, Egypt, Philippines, Brazil, Colombia, Cambodia, Myanmar, Tanzania, and Suriname were most active on our team Facebook channel.

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

The Alabama Beginning Farmer program has targeted and significantly reduced barriers to technology adoption such as the lack of awareness and access to information for ALL producers, market gardeners, educators and field consultants, and much more diverse audience. Overall satisfaction rating from field training is 76% with over 90% adoption rates for one-on-one consultations initiated by producers. According to one of our past estimates, the commercial horticulture team saved equivalent of \$26,640 through event training and consultations in one year pre-COVID. COVID-19 sparked new innovation in information delivery and on-farm consultations that supported all producers to incredible effect. Since 2018, the commercial horticulture team has been capturing success stories for cumulative assessments based on client calls for assistance. Impacts are assessed using an 8-question rapid survey with QR code printed on business cards or survey connected to the Farming Basics App for easy retrieval. In 2022, REAs and Specialists submitted a total of 24 impact cases from across the state. Respondents to the impact survey included 46 percent experienced and 33 percent new producers, 13 percent community gardeners, 4 percent military veterans and 4 percent nursery and greenhouse producers. Respondents rated Extension service

as 92 percent 'Highly satisfied' and 8 percent 'Satisfied'. About 15 estimates of direct impacts indicated profits or potential savings of \$66,700 with a range depending on the crop. Considering a minimum of \$2,880 in the estimated service cost not charged to the producers, the net return on investment (ROI) is 23:1 (\$23 return for every dollar invested). This conservative estimate excludes cases where a clear dollar estimate was not reported by individual producers, for example, 15,000 strawberry plants rescued from disease, 25 percent cabbage crop saved in Central AL due to disease, 15 percent vegetable yield improvement on a small farm, and benefits of grafting satsuma trees. The Alabama Beginning Farmer program is also working on a special project with the Alabama Institute for the Deaf and Blind (AIDB) campuses to train teachers in agriculture, develop supporting publications and resources for students with disabilities funded by grants from the Alabama Council on Developmental Disabilities and the Alabama Department of Mental Health. This will lead to further increase in Extension's collaboration and impacts in coming years. Several client testimonials are provided below!

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.

Client comments to question if Extension did not conduct training and provide support: Participant response to question "If there were NO training events or field demonstrations, what would happen?": Responses "I wouldn't farm!"; "Go without knowledge"; "Farm would fail"; "Wouldn't know who to reach out to with questions."; "Far less productivity on my farm"; "Will have info void." • "I would like to thank you for the great work that you are doing at Auburn University in agriculture that would have an impact on the plant life which would directly help in the fight against health disparities, inequalities, obesity and it's related diseases that are affecting minorities especially African Americans in disadvantage and undeserved communities at an disproportional rate." - Manatee Smith, via email Aug 16, 2022 • "Your newsletter and other forms of communication are most helpful in many ways. In your webinars and other sources of info I think it would be useful to have a link of some type that indicates the locations, professional responsibilities of the participants. This would facilitate letting interested farmers and others know a little more about the presenters, without having to search the Extension or other directories. Having said this you may already have this in the system you have developed and I have simply not found it. In any regard you are providing a great service to the people of Alabama." - Arlie Powell, email on Jan 19, 2022 "It is refreshing to see extension including OMRI approved options in their (IPM) recommendations." - Kathy Gormandy, via Facebook channel "I want you to know how much I enjoy and appreciate all the webinars that ACES puts on. Last summer my wife and I bought a 131 acre farm near Walnut Grove in Etowah County and have been working with commercial horticulture REA. Thanks again!" - Vernon Lee Sanders II, via Facebook channel "I never get to attend most meetings, due to teaching, but these are just terrific! I hope to invite some speakers for my BYS 302 course (People, Plants and the Environment) and hope I can call on some of you to present material for the students. Thanks for doing these- I know I learn a lot from the few I get to attend." - Lawana Adcock-Downey, via Facebook comment Alabama IPM/Sustainable AG Newsletter Survey (Anonymous comments from Qualtrics Survey): "Yes, they have indeed helped me. I have participated in virtual classes and read the monthly newsletter every month. They are very informative, and I enjoy them greatly. Thank you." "Easy links for information on existing programs... Like beginning farmer. Where would I go to find out about existing programs. Anyway, love this newsletter and what you guys do. Thank you." "I have very much enjoyed having this newsletter available. I use it as an informative reference and recommend it to others. Thank you." "This is the only way we connect to the research at Auburn. Those training events are great to meet the extension staff for help."

Specific outputs Number of Publications: Extension - 39 Research - 1 Total (calculated) - 40

Closing Out (end date 03/06/2024)

[Operation Grow for Beginning Veteran Farmers \(ACES & ADAI Joint Program\)](#)

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7004590



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

Alabama has a large population of military veterans transitioning to civilian life. According to the Alabama Department of Veteran Affairs (ADVA, Montgomery), major veteran issues include mental health, suicide prevention, homelessness and employment. Operation Grow Program was developed in conjunction with the Alabama Department of Agriculture and Industries (ADAI) and the ADVA to reduce mental health and increase employment among veterans interested in agriculture.

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

Operation Grow statewide program, coordinated by Harli Willis and assisted by Dr. Ayanava Majumdar, provides support to all beginning veteran farmers through structured individualized training, networking, and long-term support. Once the veteran registers for the OG program, they are guided through a 5-year 'Beginning Farmer Training Checklist' as a master document for in-person hands-on training along with the use of digital resources developed as part of the Alabama Beginning Farmer Program, such as the Farming Basics Online Course (Parts 1 and 2), E-newsletter, Webinars, Videos, and Social Media Channels. Supported by ADAI Specialty Crops Block Grants, SARE Research & Education/PDP, CPPM/Extension IPM, Organic Transitions and other USDA-NIFA Grants.

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

Veterans are directly trained and mentored, mutually networked via cohorts, and supported for the long term using a multi-team approach coordinated by ACES County Extension Coordinators, Regional Extension Agents, and Extension Specialists. Other popular educational resources include handbooks, slide charts, Farming Basics Online Course, Farming Basics App, Farming Basics Podcast, social media and video resources that are used by the veteran farmers during and beyond training with great success.

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

Based on training data in ACES system (2022) for the first-year statewide program, Operation Grow program reached 2,372 in-state participants via Extension group meetings, veteran job fairs, veteran collaboratives, veteran resource centers and offices statewide, one-on-one field visits, and regional meetings in conjunction with ADAI (funding partner), Alabama Department of Veteran Affairs, and NGOs. Demographics indicate 57% males and 43% females. 80% participants reside in rural AL and 20% were urban audience. Participants included 72% white, 21% black, 3% Asian, and 4% other races. 92% non-Hispanic and 9% Hispanic participants. In cooperation with the Alabama Beginning Farmer and other commercial horticulture Extension projects, Operation Grow also reached 10,061 participants out-of-state via multistate events and grower conferences (invited presentations by veteran organizations and funding agencies). Currently veterans are being assisted directly one-on-one by a team of CECs, REAs, and Veteran Resources Officers as a grassroots support network coordinated by Harli Willis, Program Coordinator. In OG Cohort#1, 24% veterans reside out of Alabama (perhaps active duty), while the rest are located within state. The highest concentration of registered veterans are from North Alabama (Birmingham and above) although this may be changing in coming months as awareness about OG increases. Other needs being addressed come from the needs assessment findings that include, but are not limited to: • 28% veterans have registered farms with farm names but need assistance from Extension. Taken together, veteran-owned farms have 880+ acres available for variety of ag-related businesses. • The top three veteran expectations from the Operation Grow project include locating ag resources (20%), how to get started (13%), and field training (13%). • The top three aspirations included learning about community food systems (8%), livestock production (8%), and crop diversification/specialty crop production/gardening/poultry production (4% each). • Top three barriers for beginning veteran farmers include lack of capital (19%), equipment (11%), and lack of information (8%), along with other issues that included lack of business skills/support/crop planning/readiness/support structure (5% each). • The top three immediate training needs were business planning (15%), crop production basics (15%), and farm equipment training (12%). Through a series of group meetings and workshops across AL in 2023, Operation Grow is now providing immersive learning experience to registered veterans and beyond with constant direct communication via the newsletter and email notifications. Many educational sessions are led or assisted by successful farming mentors (veterans) who are able to motivate new participants in the program.

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.

Number of Publications: Extension - 1 Research - 0 Total (calculated) - 1



2022 Hatch Project Update

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

This project addresses pathogen dynamics and therapeutic applications in warmwater aquaculture. The project incorporates vaccine development and feed-based therapeutants for important food fish species, with a primary focus on channel and hybrid catfish.

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.

Over the year, there has been a great deal of progress made with the bacterial coinfection work (Objective 1) involving *Flavobacterium columnare* (Fc), *Edwardsiella ictaluri* (Ei), and virulent *Aeromonas hydrophila* (vAh) the three most prominent bacterial pathogens in the U.S. catfish industry. Three separate trials were performed 1) Fc and Ei; 2) Fc and vAh; and 3) Ei and vAh. For trial 1, at 21 days post-challenge (dpc), the single Ei infection resulted in a cumulative percent mortality (CPM) of 90.0 ± 4.1 %, while the Fc group was found to be 13.3 ± 5.9 %. Concerning the reduced-dose coinfection treatments, similar mortality was noted in catfish initially challenged with either Ei (93.3 ± 5.4 %) or Fc (93.3 ± 2.7 %). Despite similarities in final CPM within the coinfection groups, the onset of peak mortality appeared to be delayed in fish first exposed to Fc. With Trial 2 at 96 h post-challenge (hpc), the full-dose, single vAh infection resulted in final cumulative percent mortality (CPM) of 28.3 ± 9.5 %. The CPM for the full dose Fc group was 23.3 ± 12.9 %. When the single pathogens were compared to the polymicrobial infections, the coinfective full-dose combination (98.3 ± 1.4 %) and half-dose combination (76.7 ± 17.1 %) significantly increased mortality ($P < 0.001$). Lastly, with Trial 3, at 10 d post-challenge (hpc), the full-dose, single vAh infection resulted in final cumulative percent mortality (CPM) of 25.0 ± 2.9 %. The CPM for the full dose Ei group was 11.7 ± 4.4 %. When the single pathogens were compared to the polymicrobial infections, the coinfective full-dose combination (41.7 ± 7.3 %) and half-dose combination (40.0 ± 10.4 %). From these data, it is clear that there are changes to the infection dynamics of these bacterial pathogens that need to be further evaluated within this project.

Objective two work focused on probiotic applications and was a collaboration with Dr. Mark Liles's laboratory at AU. Recently, *in vivo* pathogen challenge trials were conducted to evaluate the effects of short- and long-term feeding of AP193-amended diets on channel catfish disease susceptibility to strain ML09-119. Juvenile catfish (3.6 ± 0.3 g) were fed diets containing spray-coated AP193 (1×10^7 CFU g⁻¹) for either 36 or 72 days. Two *in vivo* challenges (36 days and 72 days post-initiation) were performed by clipping the adipose fin prior to immersion exposure with 2×10^7 CFU mL⁻¹ of ML09-119 for 30 minutes. The 36-day challenge elicited 23.7 ± 11.0 % mortality in the group fed with probiotics against 20.3 ± 7.5 % in the group fed without probiotics ($p=0.69$). The second 72-day challenge caused 31.0 ± 6.2 % mortality in the probiotic-fed group compared to 31.7 ± 16.7 % in the non-probiotic-fed fish ($p=0.95$). In summary, no differences in protection against vAh were observed at either 36d or 72d post-initiation. The lack of protective effect in our results may be explained by the storage of the probiotic-coated feed at -20°C, which may have influenced probiotic performance, although viability following cold storage was confirmed. As such, an additional, improved strain (AP193 mutant) with increased antibiotic production has been implemented for upcoming research as an additional treatment group. Additionally, another study involving AP193 was published this year (Dec 2022) based on work performed during this period. One highlight from the work was that immune gene expression was studied following feeding with AP193 and interesting trends were discerned with substantial downregulation observed in AP193-fed fish for *il1β*, *tnf-α*, and *tlr9* expression within splenic tissue, compared to that of a basal diet. Further research is needed to evaluate health-promoting microbes for aquafeeds as they are of great importance for developing new mitigation strategies against bacterial pathogens.

With respect to the assessment of immunostimulatory ingredients for use in catfish diets an ongoing project is evaluating two immunostimulants: a protease complex and an organic acid substance derived from reed-sedge peat. A 60-day trial was conducted to examine the effects of supplementary protein level, dietary formulation, and immunostimulant addition on the growth performance, immune response, and resistance to experimental *F. columnare* infection in channel catfish. Five diets were tested: 1) a high-quality fishmeal diet (32%; HQFM); 2) a high-protein soy-based diet (32%; CHP); 3) a low-protein soy-based diet (28%; CHL; predominately used in industry); 4) a low-protein soy diet supplemented with the protease complex (PC); and 5) organic acid (OA) substance in a low-protein diet. Following feeding for 60 d, juvenile channel catfish were sampled for growth performance and baseline health indicators ($n=3$ per tank; body mucus, blood for sera, kidney, and spleen). A subset of fish was then subjected to an immersion-based *in vivo* challenge trial with *F. columnare* (ALG-00-530; 10^6 CFU per mL exposure). At 60d post-initiation, there were no dietary differences in percent weight gain ($P=0.064$) or specific growth rate ($P=0.063$), but the 32% diets appeared generally perform best. The cumulative percent mortality (CPM) was different across dietary treatments ($P=0.003$). The mortality in the CLP group was higher than in the PC ($P=0.006$) and OA 50 diets ($P=0.005$). These challenge data suggest that the immunostimulant additions may be beneficial in protecting *F. columnare* compared to low-protein channel catfish diets.

Lastly, with respect to the vaccine development work, the collaborative columnaris vaccine project supported by the Southern Regional Aquaculture has been on track, and now a collection of attenuated vaccine candidates has been prepared for catfish ($n=5$) and tilapia ($n=5$) vaccination trials. Attenuated strain characterization is also underway to discern the mode of attenuation from the mutant and wild-type candidates. Vaccination trials are slated to start in January 2023 and will continue through the year, with pond trials on the agenda for next year.

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

The targeted audience for these objectives includes Southeastern region catfish producers, fish health specialists, and aquaculture research and Extension specialists who need efficacious treatment and management tools for bacterial catfish pathogens. As such, research findings were disseminated through site tours, conference presentations, extension articles and peer-reviewed publications. 3 M.S. student thesis projects are included within the scope of this Hatch project.

Conference presentations:

Wise, A.L., LaFrentz B.R., Kelly, A.M., Liles, M.R., Beck, B.H., and **Bruce, T.J.** Polymicrobial infections dynamics with *Edwardsiella ictaluri* and *Flavobacterium cova* in channel catfish (*Ictalurus punctatus*). 2022. Platform presentation. International Symposium on Aquatic Animal Health (ISAAH). Santiago, Chile.

Bruce, T.J.* An overview of columnaris disease in culture U.S. finfish: Experimental infections, disease diagnostics, and current treatments. 2022. Platform presentation. International Symposium on Aquatic Animal Health (ISAAH). Santiago, Chile.

Wise, A.L., LaFrentz, B.R., Kelly, A.M., Liles, M.R., Beck, B.H., and **Bruce, T.J.*** Investigation of polymicrobial infections in channel catfish culture: Assessments using *in vivo* pathogen challenges. 2022. Poster presentation. Western Fish Disease Workshop. Hood River, OR.

Wise, A.L., LaFrentz, B.R., Kelly, A.M., Liles, M.R., and **Bruce, T.J.*** Co-infective bacterial pathogens in channel catfish production. 2022. Platform presentation. Catfish Farmers of America Research Symposium. New Orleans, LA.

Nguyen, K.Q., **Bruce, T. J.**, Liles, M.R., and Davis, D.A. Growth performance, survival, blood chemistry, and gene expression of channel catfish (*Ictalurus punctatus*) fed probiotic-supplemented diets. 2022. Platform presentation. Aquaculture America 2022. San Diego, CA

Bruce, T.J.* 2021 AL Catfish Industry Update Meeting-Fish Diseases. 2021. Platform presentation. AL Catfish Producer Meeting. Greensboro, AL.

Allison L. Wise, Anita M. Kelly, Mark R. Liles, Benjamin R. LaFrentz, and **Timothy J. Bruce**. Coinfective bacterial pathogens in channel catfish (*Ictalurus punctatus*) production. Student poster presentation. AL American Fisheries Society Meeting 2021.

Extension articles:

Bruce, T. “The complexities of bacterial co-infections in catfish aquaculture.” ACES Extension Newsletter. Fish Farming News, 2022(1):14.

Harrison, C.E., LaFrentz, B.R., **Bruce, T.** “Development of an attenuated columnaris vaccine for catfish and other fish species in the Southern region.” ACES Extension Newsletter. Fish Farming News, 2022(1):12-13.

Peer-reviewed project publications:

Wise, A.L., B.R. LaFrentz, A.M. Kelly, L. Khoo, T. Xu, M.R. Liles, and **T.J. Bruce**. 2021. A review of bacterial co-infections in farmed catfish: Components, diagnostics, and treatment directions. Animals 11(11):3240.

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

All of these Hatch project objectives address significant issues for warmwater aquaculture producers in west Alabama, especially the AL catfish industry. Although this research is targeted, these approaches and results can also be applied to new species of interest to benefit U.S. aquaculture production as a whole. With this work, there was a connection to the industry through the communication of shared results. Long-term outcomes will also advance US aquaculture by adding to our understanding of the interrelated nature of nutrition, host health, pathogenesis, and microbial interactions associated with bacterial disease outbreaks. The results from this project will continue to shed more light on the use of feed additive vaccination practices and treatments to limit antibiotic usage.

Plant pathogenic bacterium *Xylella fastidiosa* in Alabama: distribution, evolution, and novel control methods

Project Director

Leonardo DeLaFuente

Organization

Auburn University

Accession Number

1023172



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

The bacterial plant pathogen *Xylella fastidiosa* affects the productivity of several specialty crops in Alabama, including peach, blueberry, and pecans among others. This pathogen is constantly expanding its host range and is very difficult to control since it is limited to live internally in the plant, inside the vascular system of the xylem vessels. We are studying the basis of evolution of this pathogen, to anticipate new host specificities that can occur in the future, as well as testing novel control methods.

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.

Xylella fastidiosa is a bacterium that causes incurable diseases in multiple high value crops such as grape, citrus, almond and olive, among others. In recent years the plant hosts that are affected by this bacterial pathogen is expanding, and diseases caused by this bacterium are being described in places previously unknown, such as the European continent and regions with climates cooler than tropical or subtropical, that has been historically where this pathogen has been found. *X. fastidiosa* causes diseases also in blueberry, especially in the southeastern US. Our studies show that blueberry can be infected and develop symptoms when infected with different *X. fastidiosa* subspecies, which has implications for disease management and pathogen adaptation and evolution. Moreover, during studies on exchange of genetic material (DNA) among *X. fastidiosa* we discovered that isolates infecting blueberry can acquire DNA from isolates infecting other hosts (such as grapes) and vice versa. These results indicate the possibility of rapid evolution leading to adaptation to different hosts by this pathogen. In another area of research, in a collaboration with chemical engineers, we are testing novel antibacterial nano formulations that have potential to be used systemically to control infection with xylem-limited bacteria, such as *X. fastidiosa*.

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

The target audiences include: i) undergraduate, graduate students and postdoctoral researchers through research in the laboratory and formal teaching; ii) researchers, growers, diagnosticians, government employees, agricultural workers in the US, via in person presentations; and iii) scientists, through presentations in the US, Spain, Italy and Germany.

Scientific publications:

De La Fuente, L., Merfa, M.V., P.A. Cobine, and J. J. Coleman. 2022. Pathogen adaptation to the xylem environment. *Annual Review of Phytopathology*, 60:163-86, <https://doi.org/10.1146/annurev-phyto-021021-041716>.

Soliman, M., B. Lee, A. Ozcan, T.B. Rawal, M. Young, H.C. Mendis, P. Rajasekaran, T. Washington II, S. Venkatesh Pingali, H. O'Neill, A. Gesquiere, L. De La Fuente, L. Petridis, E. Johnson, J. Graham, S. Santra, and L. Tetard. 2022. Engineered zinc oxide-based nanotherapeutics boost systemic antibacterial efficacy against phloem-restricted diseases. *Environmental Science Nano*, 9(8):2869-2886, DOI: 10.1039/d2en00263a.

Ge, Q., X. Zhu, P.A. Cobine, and L. De La Fuente. 2022. The copper-binding protein CutC is involved in copper homeostasis and affects virulence in the xylem-limited pathogen *Xylella fastidiosa*. *Phytopathology*, 112:1620-1629, <https://doi.org/10.1094/PHYTO-11-21-0488-R>.

Merfa, M.V., E. Naranjo, D. Shantharaj, and L. De La Fuente. 2022. Growth of *Candidatus Liberibacter asiaticus* in commercial grapefruit juice-based media formulations reveals common cell density-dependent transient behaviors. *Phytopathology*, 112(1):131-144, <https://doi.org/10.1094/PHYTO-06-21-0228-FI>.

O'Leary, M., L. F. F. Arias-Girald, L. Burbank, L. De La Fuente, and B. B. Landa. 2022. Complete genome resources for *Xylella fastidiosa* strains AlmaEM3 and BB08-1 reveal prophage-associated structural variation among blueberry-infecting strains. *Phytopathology*, 112:732-736, <https://doi.org/10.1094/PHYTO-08-21-0317-A>.

Ge, Q., P.A. Cobine, and L. De La Fuente. 2021. The influence of copper homeostasis genes *copA* and *copB* on *Xylella fastidiosa* virulence is affected by sap copper concentration. *Phytopathology*, 111:1520-1529, <https://doi.org/10.1094/PHYTO-12-20-0531-R>.

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

Public was reached by oral and poster presentations in different meetings.

Oral presentations:

Keynote Speaker at the “7th Xanthomonas Genomics Conference”. Clearwater, Florida, US, June 13-17, 2022. Presentation: “Natural competence and other functions of type IV pili in *Xylella fastidiosa*”.

Invited speaker at the “Summer School Nanotechnology in Agriculture”. Presentation: “Nanoformulations for xylem pathogens: *Xylella fastidiosa*”. Organized by the Department of Agriculture and Forest Sciences (DAFNE) of University of Tuscia, Italy. Viterbo, Italy, June 30-July 1, 2022.

Invited talk at “14th International Conference on Plant Pathogenic Bacteria”. Assisi, Italy, July 3-8, 2022. Presentation: “Mechanism of action of a zinc-based nanoparticle with activity against vascular plant pathogenic bacteria”

Keynote Speaker at “14th International Conference on Plant Pathogenic Bacteria”. Assisi, Italy, July 3-8, 2022. Presentation: “Mechanisms and distribution of natural competence among *Xylella fastidiosa* strains”.

Invited speaker at the Departmental seminar series of the Department of Biochemistry at the Instituto de Investigaciones Biológicas Clemente Estable (IIBCE) in Montevideo, Uruguay. Virtual zoom presentation in Spanish on 9/15/2022. Presentation: “Funciones fundamentales del pili tipo IV en la virulencia de *Xylella fastidiosa*: movimiento y evolución” (“Fundamental functions of type IV pili in *Xylella fastidiosa* virulence: movement and evolution”).

Speaker at the Institutional seminar series of the Instituto de Agricultura Sostenible – Consejo Superior de Investigaciones Científicas (IAS-CSIC), Córdoba, Spain. Presentation in Spanish on 11/4/2022. Presentation: “Evolución y adaptación al xilema por parte de la bacteria fitopatógena *Xylella fastidiosa*”.

Invited speaker at the Institutional seminar series of the Ludwig Maximilian University of Munich (LMU Munich Biocenter), SFB924 Hybrid seminar, Munich, Germany. Hybrid presentation in zoom and in person on 11/8/2022. Presentation: “Evolution and adaptation to the xylem environment by the plant pathogen *Xylella fastidiosa*”.

Poster presentations:

Naranjo E., D. Shantharaj, M.V. Merfa, S. Santra, and L. De La Fuente. 2022. Mechanism of action of a zinc-based nanoparticle with activity against vascular plant pathogenic bacteria. 14th International Conference on Plant Pathogenic Bacteria, Assisi, Italy, July 3-8, 2022.

Merfa M.V., R. Liu, N. Potnis, and L. De La Fuente. 2022. Mechanism and distribution of natural competence among *Xylella fastidiosa* strains. 14th International Conference on Plant Pathogenic Bacteria, Assisi, Italy, July 3-8, 2022.

Young M., A. Ozcan, P. Rajasekaran, A. Strayer, Y.Y. Liao, M.E. Myers, E. Johnson, J.H. Graham, J.B. Jones, M.L. Paret, D. Shantharaj, L. De La Fuente, and S. Santra. 2022. Advanced copper and Cu alternatives for crop protection. 14th International Conference on Plant Pathogenic Bacteria, Assisi, Italy, July 3-8, 2022.

R. Liu, N. Potnis, and L. De La Fuente. 2022. Using GWAS to identify genes involved in natural competence of *Xylella fastidiosa* strains. 7th Xanthomonas Genomics Conference, Clearwater, Florida, US, June 13-17, 2022.

Claudio, N., and L. De La Fuente. 2022. Interactions between *Xylella fastidiosa* strains in vitro. This is Research: Student Symposium, Auburn University, 3/26/2022.

Moll, L., M. Planas, L. Feliu, E. Badosa, L. De La Fuente, E. Montesinos, and A. Bonaterra. 2022. Nuevos péptidos con actividad bactericida y antibiofilm contra *Xylella fastidiosa*. XX Congreso de la Sociedad Española de Fitopatología (SEF), Valencia, Spain, 24-26 October, 2022.

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 been part of the professional training of multiple students at different levels in their career. During the past year, 1 undergraduate student, 3 graduate students (1 Ph.D., 2 M.S.), and 1 postdoc, all have been involved in this research. The graduate students and postdoc trained an undergraduate student in the research we conduct in our lab.

Agricultural and Rural Finance Markets in Transition

Project Director

Valentina Hartarska

Organization

Auburn University

Accession Number

1025625



Agricultural and Rural Finance Markets in Transition

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

During the year, the research work was focused on two major topics:

1. Evaluating the opportunities and challenges of Beginning Farmers and Ranchers (BFRs) -financing constraints, productivity and usefulness of support programs such as transition incentive Program (TIP) for preferential use of land in CRP.
2. Studying challenges facing women farmers in the region.

This work was in the context of the multistate's project goal to evaluate to what extent financial markets and institutions are able to meet the need of these two types of customers.

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 main activities were econometric modeling and statistical analysis of data and writing up journal articles.

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

During the period I presented my work at various conferences and published several refereed journal articles.

Refereed Journal Articles

1. Liyanage, K.D.E, D. Nadolnyak, & V. Hartarska. 2022.” Financial Inclusion of Rural and Urban Households and the Dodd-Frank Act,” *International Journal of Economics and Finance*, 14(11):90-103. [DOI:10.5539/ijef.v14n11p90](https://doi.org/10.5539/ijef.v14n11p90)
2. Nadolnyak, D. and Hartarska, V., (2022) “Nontraditional Lenders and Access to Credit in Local Markets by Beginning and Female Farmers,” *Agricultural Finance Review*, 82:2, 268-284
3. Hartarska, V., D. Nadolnyak, and N. Sehwat, (2022) “Beginning Farmers’ Entry and Survival: Evidence from County Level Data” *Agricultural Finance Review* 82:3,. 577-596
4. Cozarenco, A., V. Hartarska, and A. Szafarz, (2022) “Subsidies to microfinance institutions: How do they affect cost efficiency and mission drift?” *Applied Economics* 54:44, pp. 5099-5132.
5. K Khachatryan, A Grigoryan, V Hartarska, R Mersland, [Spillovers in Social Entrepreneurship: Spatial Proximity and Microfinance Performance](#), Academy of Management Proceedings 2022 (1), 12548

Book chapters

Parmeter C. and V. Hartarska (2022), Performance of Microfinance Institutions: A Review, *Handbook of Production Economics, Volume 2*, edited by R. Chambers, S. C. Kumbhakar and S. Ray, Springer.

Presentations

1. Adjei, Eugene, V Hartarska 2022 “An Impact Analysis of the Transition Incentive Program on Beginning Farmers and Ranchers in Rural United States” AAEA Meeting
2. Hartarska, V, R. Chen, and D. Nadolnyak “Banking Crises and Microfinance Performance,” FMAI Meetings, October 24-26, 2022 Atlanta, Georgia.
3. Hartarska, V, R. Chen, and D. Nadolnyak “Banking Crises and Microfinance Performance,” FMAI Meetings, June 29- July 3rd, 2022 Rome, Italy.
4. Grigoryan, A., K Khachatryan, V. Hartarska, and R Mersland “Are All Deposits Products in the Microfinance World Created Equal?” 7th European Research Conference on Microfinance, Glasgow, June 20-22. 2022.
5. *Khachatryan, K., A. Grigoryan, V. Hartarska, and R Mersland, “Spillovers in Social Entrepreneurship: Spatial Proximity and Microfinance Performance,” 7th European Research Conference on Microfinance, Glasgow, June 20-22. 2022.*

6. Chen Rui, Di Fang, V. Hartarska (2022). *The Affordable Care Act's Dependent Coverage Expansion: Does the ACA Mean more Young Adults' wages and Less Expenditures*, 2022 Association of 1890 Research Directors Research Symposium "The 1890 Research and Innovation Agenda: Pathways to Build Back Better", April 2-5, 2022, Atlanta

7. Adjei, Eugene, V Hartarska 2022 "An Impact Analysis of the Transition Incentive Program on Beginning Farmers and Ranchers in Rural United States" 99Th Annual Meeting of Alabama Academy of Sciences, March 16-18, Athens, AL

8. D. Nadolnyak, V. Hartarska 2022 "Beginning and Female Farmers' Productivity and Access to Credit from Traditional and Nontraditional Lenders. 99Th Annual Meeting of Alabama Academy of Sciences, March 16-18, Athens, AL

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

Many farmer organizations representing BFRs and women farmers as well as USDA and other governmental agencies are interested in knowing how they can help BFRs and women farmers and what kind of support can be helpful. In fact, a commercial lender from Midwest approached me and my co-authors requesting our paper on non-traditional lending for BFRs and women farmers.

Expected outcomes from this work are ultimately to decrease in the number of producers and rural entrepreneurs unable to get the financing that they need to meet their investment needs. We also expect an increase in the number of producers who will be able to grow as a result of being able to fund non-traditional projects. We expect a change in knowledge of how creditors are able to meet the financial needs of producers especially small size and beginning producers, whom they typically ration. The expectation is that this knowledge will enable creditors to better meet the needs of producers, as well as that the producers will be able to access larger pools of credit or special funding and thus expand their operations and grow.

Food Safety Training for Food Service Workers

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7002288



Food Safety Training for Food Service Workers - Annual

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

Beginning in 2010, the Alabama Department of Public Health (ADPH) mandated that a person (generally the manager) have a food protection manager certification for inspected facilities. During the inspection process, documentation would have to be shown that this mandate was being met. In 2020 following the guidance of the 2017 FDA Food Code, the Person In Charge, had to be a certified food protection manager and must be onsite at all times operating hours according to ADPH. The Food Safety & Quality team of the Alabama Cooperative Extension System provides this certification training through the nationally recognized ANSI accredited program ServSafe™. This training is presented in most of the 67 counties of Alabama.

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 total of 132 two-day food protection manager certification classes (ServSafe) for food service workers were offered in Alabama counties. Nineteen individuals were proctored for the ServSafe Manager Protection Exam. As a result of these classes and proctoring, over 1,150 food service workers completed the certified food safety training resulting in a 68% passage rate. These numbers include classes taught by a team member, with our partner university, in Spanish to help server that population. Individuals not passing the certification exam are given an hours of training form that allows the facility to

continue operation until a future re-attempt for certification. Therefore, by conducting these trainings, whether an individual receives certification or not, the facility for whom they work can continue to generate revenue and contribute to the local economy.

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

By doing the ServSafe™ Trainings, the Food Safety & Quality team is:

- Providing accessibility of an approved Food Protection Manager Certification for food service workers in the state
- Helping clientele identify food safety standards and their importance in the food industry
- Helping clientele recognize the importance of developing and implementing specific policies or standard operating procedures to assist in the prevention of foodborne illness
- Helping clientele understand the importance of training and supervising food preparation employees to help protect consumers
- Helping clientele identify proper food safety measures, applicable regulations, essential worker hygiene, and techniques to maintain food safety in their specific food-oriented environment

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

The Centers for Disease Control and Prevention (CDC) estimates that approximately 9 million people get sick, 56,000 are hospitalized and about 1,300 die as a result of foodborne illnesses annually (2020). These estimates are down from the 48 million get sick, 128,000 are hospitalized and 3,000 die that was reported by CDC in 2013. Proper training of food service workers has helped to reduce these numbers by emphasizing the importance of food safety principles. A CDC study suggests that the presence of a Certified Food Protection Manager reduces the risk of a foodborne illness outbreak for an establishment and that it was a distinguishing factor between restaurants experiencing foodborne illness outbreaks versus those that did not have one. By providing this training locally in Alabama counties, the Food Safety and Quality team are equipping food service personnel with the necessary information to be instrumental in helping to reduce the incidence of foodborne illness.

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.

Whereas other entities, including the National Restaurant Association, offer this training both virtually and in person, it is becoming more difficult to compete for clients as we must offer this class in person and to help clients understand the information better, we offer a two-day format. With the current lack of available staff, we are finding it harder and harder to attract clients. Also, we have fewer agents serving the state, leading to larger geographical areas, and this limits the ability to offer classes in a timely manner. This leads to a disadvantage to offer classes, especially when only have one or two registering and these are two-day, intense trainings that require extensive travel and set up.

Grow More, Give More: A program to teach gardening, engage volunteers, and fight food insecurity

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7002283



Grow more, Give more - Annual

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

Many communities suffer from food insecurity. This program addresses food deserts through the development of home and community gardens.

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 goal of GMGM is to teach adults how to start their own gardens and grow an extra row to share within the community. This program uses best management practices along with a volunteer component that assists with donations within the community. The end result brings fresh fruits and vegetables to our gardeners builds community engagement and encourages healthy eating. In conjunction with the Master Gardener program, GMGM donated 44,696 pounds (22.3 Tons) of produce. REAs recorded 10,108 direct contacts in 2022 with 26% related to grow more give more and 74% to Alabama Smart Yards.

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

This program offered 96 events statewide that were REA led. Master Gardener volunteers were an integral part of the program by maintaining 11 demonstration gardens. Overall there were 5,575 participants. With 4,332 indirect contacts and 2,947 app downloads. There were 11,498 pounds of produce donated directly from this program. With 4,369 transplants were donated to individuals and communities. Several programs were offered. Some events held were Veteran Gardening, Totally Tomato, Raised Beds, Small Space Gardening, fruit Tree pruning, Sensory Gardens, Edible Landscapes, Seed Starting Workshop, and basic vegetable gardening amongst many others. The average number events each person attended was 10.6. This means our learners keep coming back. Program participants reported an average program value of \$76.00 dollars per program with an average cost savings of 176 per program. Based on an retail average of \$2.00, the 2022 GMGM donations totaled \$22,996.00. This program is in collaboration with many other programs. Such as Extension Master Gardener, Commercial Horticulture, Extension Food Safety and SNAP-Ed Agents, 4-H and County Extension Coordinators.

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

96 programs were implemented in 66 zip codes. The community continues to see value in this program. In 2022, 4,369 transplants were shared throughout the state. Participants can register their garden to record donations. Recipes are shared to help gardeners make the most of their produce along with guides demonstrating how to properly care for their new plants. The return on investment was 44:1

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.

4 Extension Publications created

Nutrition and feed management for warm water fish and shrimp.

Project Director

Donald DAVIS

Organization

Auburn University

Accession Number

1025467



Nutrition and feed management for warm water fish and shrimp.

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

Continuing population growth, as well as increased standards of living, is driving an expanding demand for high quality seafood products. This has resulted in seafood being the most traded food item in the world. Due to limitations of supply from wild stocks the increasing demand has maintained commercial production of aquatic species as the fastest growing component of agriculture. As feed represents the primary cost in rearing animals, the development of cost-effective feeds and feed management strategies is critical to industry. Hence, this research works on practical nutritional issues facing the warm water aquaculture 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.

Research is conducted at the E. W. Shell Research Station, Claude Peteet Mariculture Center (Gulf Shores, AL), and Fish Farming Center (Greensboro, AL). The aquatic animal nutrition program emphasizes applied research in warm water fish and shrimp nutrition. The overall goal of the program is to improve technologies for the culture of marine (e.g. Florida pompano, yellow tail snapper, and white shrimp) and freshwater (e.g. catfish and tilapia) species through improved diet formulations and culture technologies.

Research with marine species included: 1. The evaluation of plant-based shrimp feeds containing various levels of protein on the performance of Pacific white shrimp reared under pond production conditions using on demand acoustic feeders. 2. The evaluation of various alternative protein sources for shrimp and Florida pompano. 3. Development of techniques to determine dietary amino acid requirements of Pacific white shrimp. 4. The evaluation of the interaction of dietary protein and feed inputs in green-water systems for shrimp. 5. The development of basic nutrition research for yellow tail snapper. Work with freshwater species included: A. Use of corn by product meals as feed ingredient for catfish and tilapia. Results of these trials are expected to help us improve feed formulations as well as feed management strategies.

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

Toward the education of industry professionals, my program supports seven PhD and two MS. students all receiving training in aquaculture, aquatic animal nutrition and laboratory management. Historically, most of my students have entered the aquaculture industry and are hence directly contributing to its development and expansion. My group has presented over 24 presentations at conferences and industry training programs to transfer this information to the industry. We published three book chapters, 19 journal publications as well as three popular articles to promote industry education. The results of our work directly impact the aquaculture industry through improved feed formulations and a better understanding of feed management. Cumulatively, these results add to the sustainability and development of seafood production through aquaculture.

PUBLICATIONS

Nguyen, K.Q., T. J. Bruce, O. E. Afe, M. R. Liles, B. H. Beck and D. A. Davis. 2022. Growth Performance, Survival, Blood Chemistry, and Immune Gene Expression of Channel Catfish (*Ictalurus punctatus*) Fed Probiotic-Supplemented Diets. *Veterinary Sciences*. 9(12): 701. doi:10.3390/vetsci9120701

Hernández, D. P., H. A. Abdelrahman, H. S. C. Galkanda-Arachchige, A. M. Kelly, I. A. E. Butts, D. A. Davis, B. H. Beck, L.A. Roy. 2023. Evaluation of aqueous magnesium concentration on performance of Pacific white shrimp (*Litopenaeus vannamei*) cultured in low salinity water of West Alabama, USA. *Aquaculture*.

Peixoto, S., L. Strebel, R. Soares, and D. A. Davis, 2022. Acoustic feeding responses using marine chemoattractants in plant-based diets for naïve and non-naïve *Litopenaeus vannamei*. *Applied Animal Behaviour Science*. 257:105792.

Nazeer, S., S. Tilton and D. A. Davis. 2022. Evaluation of a high protein distiller's dried grains with yeast as a protein source in practical diets for Pacific white shrimp *Litopenaeus vannamei*. *North American Journal of Aquaculture* <https://doi.org/10.1002/naaq.10272>

Walsh, S., Nguyen, K., Strebel, L., Rhodes, M. & Davis, A. 2022. Utilizing feed effectors and automated feeders for Semi-intensive pacific white shrimp (*Litopenaeus vannamei*) production. *Aquaculture, Fish and Fisheries*, 2:540–551. <https://doi.org/10.1002/aff2.83>

Nazeer, S., A. Fredricks, O. E. Afe, B.J. Bench, Z. Thompson, D. A. Davis. 2022. Use of poultry corn by-product meal on the growth performance of channel catfish, *Ictalurus punctatus*. *Aquaculture Journal*. 2(3), 216-226; <https://doi.org/10.3390/aquacj2030012>

Salem, S., L. Nguyen, T. I. Mohamed, O. A. Orma and D. A. Davis. 2022. Efficacy of Crystalline Amino Acids Supplementation in Reduction of Intact Protein Level in Channel Catfish *Ictalurus punctatus* Diets *Animal Feed Science and Technology*. 292:115428

Nazeer, S., A. Fredricks, O. E. Afe, B.J. Bench, Z. Thompson, D. A. Davis. 2022. Use of poultry corn by-product meal on the growth performance of channel catfish, *Ictalurus punctatus*. *Aquaculture Journal*. 3(3):216-226.

Nguyen, L. S. M. R. Salem; G. P. Salzes; H. Dinh; and D. Allen Davis. 2022. Indispensable and dispensable amino acid supplementation in diets offered to Nile tilapia *Oreochromis niloticus*. *Animal Feed Science and Technology*. 290:115361. <https://doi.org/10.1016/j.anifeedsci.2022.115361>

Swanepoel, A., G.A. H. S. Chathuranga, X. Qiu and D. A. Davis. 2022. Utilization of crystalline amino acids by Pacific white shrimp *Litopenaeus vannamei*. *Journal of Applied Aquaculture*. <https://doi.org/10.1080/10454438.2022.2080517>

Davis, R., C. E. Boyd, A. Gonzalez; O. Shatova, J. Wakefield, B. Harris; A. McNevin, and D. A. Davis. 2022. Sources of variation in elemental profiles and their potential effects on the accuracy of discriminant analysis. *Journal of Trace Elements in Medicine and Biology*. 71: 126961. <https://doi.org/10.1016/j.jtemb.2022.126961>

Reis, J., A. S. Peixoto, R. Soares, M. Rhodes, C. Ching and D. A. Davis. 2022. Passive acoustic monitoring as a tool to assess feed response and growth of shrimp in ponds and research systems. *Aquaculture*. 546: 737326 <https://doi.org/10.1016/j.aquaculture.2021.737326>

Davis, R.P., C. E. Boyd, R. Godumala, A. B. Ch. Mohan, A. Gonzalez; N. P. Duy; N. Ahyani; P. G. Sasmita, O. Shatova; J. Wakefield; B. Harris; A. A. McNevin, and D. A. Davis. 2022. Assessing the variability and discriminatory power of element fingerprints in white leg shrimp *Litopenaeus vannamei* from major shrimp production countries. *Food Control*. <https://doi.org/10.1016/j.foodcont.2021.108589>

Nazeer, S., D. C. Fornari, H. S. C. Galkanda-Arachchige, S. Tilton and D. A. Davis. 2022, Use of high protein distiller's dried grain with yeast in practical diets for the channel catfish, *Ictalurus punctatus*. *Aquaculture*. 546 <https://doi.org/10.1016/j.aquaculture.2021.737387>.

Zhang, D., H. Mohammed, Z. Ye, M. A. Rhodes, W. Thongda, H. Zhao, L. N. Jescovitch, S. A. Fuller, D. Allen Davis, and E. Peatman. 2022. Transcriptomic profiles of Florida pompano (*Trachinotus carolinus*) gill following infection by the ectoparasite *Amyloodinium ocellatum*. *Fish and Shellfish Immunology*. 125:171-179.

Hussain, A. S., D. A. Mohammad, W. S. Dallam, N. M. Shoukry and D. A. Davis, 2022, Effects of culturing the Pacific white shrimp *Penaeus vannamei* in "biofloc" vs "synbiotic" systems on the growth and immune system. <https://doi.org/10.1016/j.aquaculture.2021.736905>

Hussain, A., H. S. Peixoto, R. Soares, J. Reis, and D. A. Davis 2022. Evaluation of extruded feeds with no or low inclusion of fishmeal on growth performance of Pacific white shrimp *Penaeus vannamei* in clear water and biofloc systems *Aquaculture Research*. 3:1947–1955.

Davis, R.P., C. E. Boyd, A. Gonzalez; O. Shatova; J. Wakefield; A. A. McNevin, and D. A. Davis. 2022. The effect of commercial scale processing on trace element concentrations in shrimp muscle tissue – A preliminary study from two processors in Thailand and Ecuador. *Journal of Food Composition and Analysis*. 108: 104442

Galkanda-Arachchige, H.; A., Hussain, D. A. Davis. 2022. "Improvement in laboratory research: effects of stocking density, variation, and sample size". *Aquaculture Research*. 53 (3): 843-850.

Galkanda-Arachchige, H., L. A. Roy, A. M. Kelly and D. A. Davis. 2022. Can a low-cost salt mixture replace sea salts for low salinity shrimp farming? *Global Aquaculture Alliance*. 16 May 2022.

Walsh, S., K. Nguyen. L. Strebel, M. A. Rhodes and D. A. Davis. 2022. Attractants, acoustics and soy-optimized diets for Pacific white shrimp. *Responsible Seafood Advocate*. January 24, 2022

Weldon A, Davis DA, **Roy LA**. 2022. Shrimp in Alabama. *Alabama Cooperative Extension Fact Sheet*. ANR-1028. 4pp. <https://www.aces.edu/blog/topics/coastal-programs/shrimp-in-alabama/>

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

Currently global production of seafood from capture fisheries and aquaculture are estimated to contribute close to 25% of total animal protein consumed and consequently represents a significant component of global food security. Representing over 50% of world's seafood supply, the aquaculture industries not only provides food but it provides major employment opportunities. North America has a well-managed and rich capture fishery. Yet, because of the demand for seafood North America is one of the world leaders in seafood imports. The expansion of domestic seafood production will not only increase the availability of high quality food resources, but it will also increase our food security, provide a host of jobs through direct and indirect employment and reduce our trade deficit from seafood imports.

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 School of Fisheries, Aquaculture and Aquatic Sciences has an established reputation for working closely with the industry through research and extension. The PI program is very co-operative and interacts with a range of industry and research groups. We receive considerable industry input as well as support allowing for excellent linkages to industry. We participate in scientific as well as industry-based meetings. To ensure transfer of information from, and to, the industry the PI regularly participates in industry training programs, outreach activities and industry tours. Consequently, our future research will be based on both scientific needs as well as industry inputs.

The approaches utilized in this research are typical for animal research and as such are subject to the same constraints and problems. We will continue to improve our standard operating procedures, there are no major issues anticipated. Previously, we have outlined student training and listed publications pertaining to our research.

Urban Agriculture Food Production Systems

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002400



Urban Agriculture Food Production Systems (ANNUAL)

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

According to a recent USDA report, within several of our urban areas, American consumers are limited in their ability to access affordable healthy food because they either live far from a grocery store/supermarket or do not have access to transportation. It is estimated that about 2.3 million people (or 2.2% of all U.S. households) live more than one mile away from a supermarket and do not own a car. The Urban Agriculture Food Production Systems is a program that provides education and training concerning research-based agricultural methods and business process management strategies to support food production and city planning efforts.

Target Audience: In FY2022, the Urban Ag Food Systems program reached 7,373 individuals through 91 scheduled activities. Urban Ag accounted for 38% (n=7,373) of total Urban Home Grounds programming. Urban Ag participants were 70% adults (n=5,145), 23% youth (n=1,618), 50% black (n=3,647), 33% white (n=2,454), 27% male (n=1,966), and 60% female (n=4,364).

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 program's goals and objectives were accomplished with 91 activities implemented during the FY2022. Most activities were hybrid workshops, demonstrations via mobile classroom and online Back 2 Basics Wednesdays training sessions. Other activities included educational resource distributions, participation and demonstrations at lunch and learn and gardening workshops, county earth day events, tv interviews, radio interviews, social media posts, newsletter articles, flyers, newspaper articles, and extension blogs.

Hybrid workshops and online sessions were used to help participating clientele learn more about our nation's Agriculture Industry, Urban Ag, BMPS, and IPMs practices. The programming and developed educational resources were used to help urban clientele with starting and managing a backyard garden or community garden. Comparison of the pretest and posttest scores indicated a significant percentage change or increase in participants' knowledge or understanding of the following:

Backyard and Community Gardening (n = 7,373):

- Knowing the importance of water availability (67% increase)

- Knowing the impact of irrigation systems (84% increase)
- Learning at least four ways to conserve water in the garden (74% increase)
- Learning the significance of soil test (86% increase)
- Learning the importance of how to conduct a soil test (89% increase)
- Learning the importance of location and planning (85% increase)

The average score for clientele's overall knowledge of Urban Ag, BMPs, and IPMs increased by 80%.

BMPs for Urban Ag Food Production Systems (n = 7,373):

- Know the importance and use of BMPs (82% increase)
- Know the importance of composting (88% increase)
- Know the methods of weed control (77% increase)
- How to use cultivation practices to control weeds (85% increase)
- How to use timers and drip irrigation (68% increase)
- How to use plasticulture and drip irrigation as management practices (80% increase)

The average score for the clientele's overall knowledge of BMPs increased by 80%.

IPMs for Urban Ag Food Production Systems (n = 7,373):

- Know the importance and use of IPMs (67% increase)
- Know what Integrated Pest Management involves (84% increase)
- Know the importance of beneficial insects (92% increase)
- The importance of using trap plants/crops (87% increase)
- Know the importance of pollinators and pollinator gardens (92% increase)
- Know how to use trap crops in gardens (87% increase)

The average score for clientele's overall knowledge of how to create a basic IP management plan increased by 85%.

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

The Urban Agriculture Food Production System workshops and added innovative demonstrations provided hands-on training and demonstrative support for urban clientele to adopt methods that will help start, manage, and sustain their backyard or community garden. Approximately seven weeks after participating in our programs, clientele continued to use the information and skills gained from our programs.

Results from the delayed post-assessment were (n=2,360):

- Choosing the location for a garden (80%)
- Watering more efficiently using a timer (90%)
- Watering more efficiently using drip irrigation (89%)
- Scouting for pests regularly (76%)
- Conducting a soil test regularly (67%)

- Purchased or built a rain barrel for use (56%)
- Purchased and planted a trap plant/crop (52%)
- Adopted plasticulture and irrigation (68%)

Sample comments: “...limited space does mean limited gardening potential!”, “Pest management seems more manageable.”, “I didn’t know a small garden can still be so productive”, “I didn’t know the benefits of plasticulture in small spaces.”, “I’ll be back!”, “Great program and wonderful speakers!” Resulting impacts: Urban Ag overall: 93% increase in using urban ag best management practices.

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

Implementation of this program provided benefits to the broader community through increased food security and self-sustainability since gardeners were able to complete all of the steps in starting a garden from scratch and working the gardens through the growing season.

Image Analysis of Rhizospheric Interactions

Project Director
Paul Bartley
Organization
Auburn University
Accession Number
1024745



Image Analysis of Rhizospheric Interactions

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

This research addresses concerns in resource management, productivity, and sustainability in the production and management of ornamental horticultural crops. Specifically, efforts pertaining to this project improve our understanding of irrigation and nutrient fate and their effects on plant growth and development.

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

Through both federal and institutional support, we made significant progress toward the objectives outlined in this project. These efforts resulted in three (3) peer-reviewed scientific publications, five (5) scientific presentations, three (3) published abstracts, and two (2) industry presentations. We advanced our understanding of soilless substrate materials and management strategies to improve their efficiency in horticultural applications.

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

Publications:

Bartley III, P.C., T.C. Yap, B.E. Jackson, W.C. Fonteno, M.D. Boyette, B. Chaves-Cordoba. Quantifying the sorptive behavior of traditional horticultural substrate components based on initial hydraulic conditioning. *HortSci.* 58(1). <https://doi.org/10.21273/HORTSCI16698-22>

Bartley III, P.C., B.E. Jackson, W.C. Fonteno. A review and analysis of horticultural substrate characterization by sieve analysis. *HortSci.* 57(6). <https://doi.org/10.21273/HORTSCI16583-22>

Bartley III P.C., A. Amoozegar, W.C. Fonteno, B.E. Jackson. Particle density of horticultural substrates. *HortSci.* 57(3):379-383. <https://doi.org/10.21273/HORTSCI16319-21>

Abstracts:

Bartley III, P.C. <i>In-situ analysis of soilless substrate physical and hydraulic properties in plug production.</i> HortSci 57(9):S112. https://doi.org/10.21273/HORTSCI.57.9S.S1
Bartley III, P.C. , D. Watts, A. Torbert. <i>The influence of flue-gas desulfurization gypsum on soilless container substrates.</i> HortSci 57(9):S112. https://doi.org/10.21273/HORTSCI.57.9S.S1
Erbrick*, L., P.C. Bartley , D. Watts, A. Torbert. <i>Flue gas desulfurized gypsum affects phosphorus leaching in container pine bark substrates.</i> HortSci 57(9):S112. https://doi.org/10.21273/HORTSCI.57.9S.S1

Scientific Oral Presentations:

Bartley III, P.C. , D. Watts, A. Torbert. <i>Influence of flue gas desulfurization gypsum on phosphorus loss in pine bark substrates.</i> American Society of Horticultural Science. Chicago, IL. Aug 2.
Bartley III, P.C. <i>In-situ analysis of soilless substrate physical and hydraulic properties in plug production.</i> American Society of Horticultural Science. Chicago, IL. Aug 1.
Erbrick*, L., P.C. Bartley , D. Watts, A. Torbert. <i>Flue gas desulfurized gypsum affects phosphorus leaching in container pine bark substrates.</i> Southern Region American Society of Horticultural Science. New Orleans, LA. Feb 12.

Scientific Poster Presentations:

Erbrick*, L., P.C. Bartley , D. Watts, A. Torbert. <i>Flue gas desulfurized gypsum affects phosphorus leaching in container pine bark substrates.</i> Auburn Research Student Symposium. March 28.
Erbrick*, L., P.C. Bartley , D. Watts, A. Torbert. <i>Flue gas desulfurized gypsum affects phosphorus leaching in container pine bark substrates.</i> Southern Region American Society of Horticultural Science. New Orleans, LA. Feb 12.

Industry Extension Presentations:

Austin Lindquist*, P.C. Bartley III , J. Pickens. Moisture sensors showcase. Ornamental Horticulture Research Center Field Day. Mobile, AL. Oct 10. 50 Attendees.
Kati Kent*, P.C. Bartley III , J. Pickens. How to read a moisture sensor EKG. Ornamental Horticulture Research Center Field Day. Mobile, AL. Oct 10. 50 Attendees.

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

Our work has directly benefited members of horticultural products and services by providing and demonstrating means to manage production systems sustainably. Indirectly, the broader public benefits from horticultural commodities at a potentially lower environmental tax.

Enhancing Poultry Production Systems through Emerging Technologies and Husbandry Practices

Project Director

Wilmer Pacheco

Organization

Auburn University

Accession Number

1023284



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

The United States Poultry and Egg Association, the worlds' largest and most active poultry industry organization, has identified the need for incorporating engineering and technology to enhance energy/resource efficiencies for layers, broilers, and turkeys. In addition, this non-profit organization considers its strategic objectives to be responsive to the changing needs of the poultry industry, to advance research in poultry science and technology, and to address the safety of processed poultry and poultry products. Past and ongoing research from this multi-state organization is in direct alignment with these objectives in terms of providing a collaborative approach to enhance poultry research in the area of nutrition, environmental control, air quality, housing systems, lighting, automation and robotics, food safety and security, health and bird welfare.

The team at Auburn University work in the areas of pre/post harvest food safety and feed milling. Though these areas do not fully cover what is described above it does cover food safety, bird nutrition, health and welfare.

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 activities in pre- and post-harvest food safety as well as in feed milling. Have helped in identifying possible reservoirs of *Campylobacter* and *Salmonella* on and around commercial poultry farms. It has also shown that these same two food-borne pathogens' isolate varies in the poultry system. This is important in that possible target intervention strategies can be developed to eliminate them from the system.

With feed milling, the further refinement of the produced pellet and the ability to measure the particle size of the processed feed will further improve the uptake of nutrients by the birds as well as help feed mill operators maintain good quality of their feed.

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

The target audience of poultry farmers, poultry company representatives, researchers, government regulators and consumers. Benefited in that we were able to provide research based information that allowed them to choose proper management of their farm, feed mill, processing plant, and provide advice on policy development as well as inform consumers on what is being done to keep their food safe and nutritious.

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

By helping to provide a safe and nutritious food we are able to ensure the health of the public.

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

We provide our data to a variety of audiences, from the poultry consumer to company and allied industry personnel as well as to government agencies. There is not enough provided space to capture everything, below is a summary of our outputs.

Outputs

Peer-Reviewed Publications

1. Carrisosa, M., M.T. Terra-Long, J. Cline, **K.S. Macklin**, T. Dormitorio, C. Wang and R. Hauck. 2022. Multilocus sequence typing of *Eimeria maxima* in commercial broiler flocks. *Avian Disease* 66(4), 1-7. <https://doi.org/10.1637/aviandiseases-D-22-00040>
2. Fatemi, S.A., K.S. Macklin, L. Zhang, A. Mousstaaid, S. Poudel, I. Poudel, E.D. Peebles. 2022. Improvement in the Immunity- and Vitamin D3-Activity-Related Gene Expression of Coccidiosis-Challenged Ross 708 Broilers in Response to the In Ovo Injection of 25-Hydroxyvitamin D3. *Animals* 12(19), 2517 <https://doi.org/10.3390/ani12192517>
3. Bailey, M.A., J.B. Hess, J.T. Krehling and K.S. Macklin. 2022. Effects of Feed-Through Sulfur on Growth Performance, Atmospheric Ammonia Levels, and Footpad Lesions in Broilers Raised Beginning with Built-Up Litter. *Animals* 12(17),

4. Fatemi, S.A., K.E.C. Elliot, **K.S. Macklin**, A. Bello and E.D. Peebles. 2002. Effects of the in ovo injection of vitamin D3 and 25-Hydroxyvitamin D3 in Ross 708 broilers subsequently challenged with coccidiosis: II immunological and inflammatory responses and small intestine histomorphology. *Animals* 12(8), 1027. <https://doi.org/10.3390/ani12081027>

5. Bailey, M.A., D.V. Bourassa, J.T. Krehling, *L. Munoz, K.S. Chasteen, *C. Escobar and **K.S. Macklin**. 2022. Effect of common litter management practices on the prevalence of *Campylobacter jejuni* in broilers. *Animals* 12(7), 858. <https://doi.org/10.3390/ani12070858>

6. Smith, R., R. Hauck, **K. Macklin**, S. Price, T. Dormitorio and C. Wang. 2021. A review of the lesser mealworm beetle (*Alphitobius diaperinus*) as a reservoir for poultry bacterial pathogens and antimicrobial resistance. *Worlds Poultry Science*. <https://doi.org/10.1080/00439339.2022.2003172>

7. Pacheco, W., D.B. Patino, J.I. Vargas, J.P. Gulizia, **K. Macklin**, T.J. Biggs. 2021. Effect of partial replacement of inorganic zinc with zinc methionine and manganese methionine on live performance and breast myopathies of broilers. *Journal of Applied Poultry Research*. 30(4) <https://doi.org/10.1016/j.iapr.2021.100204>

8. Beckmann, J.F., T. Dormitorio, S.O. Oladipupo, M.T. Bethonico, K. Lawrence, **K. Macklin** and R. Hauck. 2021. *Heterakis gallinarum* and *Histomonas meleagridis* DNA persists in chicken houses years after depopulation. *Journal of Veterinary Parasitology*. 298 <https://doi.org/10.1016/j.vetpar.2021.109536>

9. **Bourassa, D.V.**, R.J. Buhr, C.E. Harris, and L.N. Bartenfeld Josselson. 2021. Assessment of stabilized hydrogen peroxide for use in reducing *Campylobacter* levels and prevalence on broiler chicken wings. *J. Food Prot.* 84:449-455.

10. De Souza, C., C. Eyng, A. AM. Viott, A. S. de Avila, **W. J. Pacheco**, N. R. Junior, T. L. Kohler, K. I. Tenorio, E. H. Cirilo, and R. V. Nunes. 2021. Effect of dietary guanidinoacetic acid and nucleotides supplementation on growth performances, carcass traits, meat quality and occurrence of myopathies in broilers. *Livestock Science*. 251: 104659

11. Alfaro, J. F., S. Rodriguez-Zas, B. R. Southey, R. Muntifering, S. P. Rodning, **W. J. Pacheco**, and S. Moisés. 2021. Complete blood count analysis on beef cattle exposed to fescue toxicity and rumen-protected niacin supplementation. *Animals*. 11(4), 988; <https://doi.org/10.3390/ani11040988>

12. Schnuelle G, E.K. Blythe, R. Cole, S. Taylor, G. F. Alfaro, R. B. Muntifering, **W. J. Pacheco**, S. P. Rodning, and S. J. Moisa. 2021. Evaluation of alterations in uterine blood flow using Doppler ultrasonography in pregnant, genotyped beef cows consuming endophyte-infected tall fescue seeds and supplemented with rumen-protected niacin. *J. Vet. Sci. Res.* DOI: 10.23880/oajvsr-16000207.

13. Bethonico Terra, M. T., **W. J. Pacheco**, M. Harrison, B. A. McCrea, and R. Hauck. 2021. A survey of coccidia and nematodes in pastured poultry in the state of Georgia. *Avian Diseases*. 65(2):250-256

14. Broch, J., V. D. L. Savaris, L. Wachholz, E. H. Cirilo, G. L. S. Tesser, **W. J. Pacheco**, C. Eyng, G. M. Pesti and R. V. Nunes. 2021. Influence of phytate and phytase on performance, bone, and blood parameters of broilers at 42 days old. *S. Afr. J. Anim. Sci.* 51:160-171.

15. Leiva, S. F., J. L. Sandoval, G. Abascal Ponciano, J. L. Flees, A. J. Calderon, **W. J. Pacheco**, and C. W. Starkey. 2022. Improper sample preparation negatively affects near infrared reflectance spectroscopy (NIRS) nutrient analysis of ground corn. *Animal Feed Science and Technology*. 293:115492

 16. Hernandez, J. R., J. P. Gulizia, J. B. Adkins, M. S. Rueda, S. I. Haruna, **W. J. Pacheco**, and K. M. Downs. 2022. Effect of phytase level and form on broiler performance, tibia characteristics, and residual fecal phytate phosphorus in broilers from 1 to 21 days of age. *Animals* 2022, 12, 1952. <https://doi.org/10.3390/ani12151952>

 17. Gulizia, J. P., M. S. Rueda, F. K. Ovi, S. M. Bonilla, R. Prasad, M. E. Jackson, O. Gutierrez, and **W. J. Pacheco**. 2022. Evaluate the effect of a commercial heat stable phytase on broiler performance, tibia ash, and mineral excretion from 1 to 49 days of age assessed using nutrient reduced diets. *J. Appl. Poult. Res.* 31(3):100276.

 18. Downs, K. M., J. P. Gulizia, E. K. Stafford, and **W. J. Pacheco**. 2022. Influence of varying dietary kudzu leaf meal particle size on performance, breast weight, and organ weight of broiler chickens from 1 to 21 days of age. *Poultry* (1) 30-39. doi.org/10.3390/poultry1010004.

 19. Jones, M. K., J. E. Ferrel, F. L. S. Castro, and **W. J. Pacheco**. 2022. The effects of various levels of distillers dried grains with solubles (DDGS) and a dacitic (rhyolitic) tuff breccia on pellet production rate and durability. *J. Appl. Poult. Res.* 31:100250.

 20. Rueda, M., A. A. Rubio, C. W. Starkey, F. Mussini, and **W. J. Pacheco**. 2022. Effect of conditioning temperature on pellet quality, performance, nutrient digestibility, and processing yield of broilers. *J. Appl. Poult. Res.* 31:100235.

 21. Hauck, R., and **W. J. Pacheco**. 2021. Detection of *Coccidia* Oocysts in Litter and Feces of Broilers in a Floor Pen Trial. *Journal of Parasitology*. 107(6). 878-881.

 22. Ayres, V. E., M. E. Jackson, S. A. Cantly, S. J. Rochell, B. C. Bodle, **W. J. Pacheco**, M. S. Rueda, C. A. Bailey, K. Gardner, T. P. Boltz, and J. S. Moritz. 2021. The effects of Optiphos and Optiphos Plus on 21-day broiler performance and tibia mineralization. *J. Appl. Poult. Res.* 30:100210.

 23. Brooks, L.A., M.A. Bailey, J.T. Krehling, K.S. Chasteen and **K.S. Macklin**. 2021. A comparison of colonizing ability between *Salmonella* Enteritidis and *Salmonella* Heidelberg in broiler chickens challenged through feed administration. *Foodborne Pathogens and Disease*. 18(11) <https://doi.org/10.1089/fpd.2021.0016>
- Over 34 peer reviewed abstracts presented at professional meetings, two conference papers given at international industry meetings, over 56 invited presentations given to our target audience in the USA as well as abroad, over 35 extension deliverables that were primarily aimed at our target audience in Alabama, and five MS students were graduated.

Epidemiology and Disease Management for Aquatic Species Cultured in west Alabama

Project Director

Anita Kelly

Organization

Auburn University

Accession Number

1022364



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

This project addresses the need of disease diagnostics and tracking within aquacultured species in west Alabama with emphasis on channel catfish, hybrid catfish, tilapia, crawfish, largemouth bass, bluegill, redear sunfish, crappie, and grass carp as well as low salinity shrimp production. Additionally, this project also pursues methods to reduce and prevent diseases in west Alabama.

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

Research carried out during this project year helped advance the knowledge of improved aquaculture production strategies to reduce disease outbreaks and improve financial stability of aquaculture operations in west Alabama. Research carried out on production practices and management (winter feeding strategies/use of probiotics in feeds) and water quality has provided new knowledge to commercial aquaculture producers. Low salinity shrimp producers have benefited based on research on shrimp health and alternative feed methods. This stakeholder driven research has addressed direct problems posed by producers through applied research and Extension activities.

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

The target audience reached through the efforts of this project, include, catfish farmers, processors, feed mills, harvest crews, low salinity shrimp farmers, crawfish farmers, catfish farmers looking to diversify and other stakeholders associated with aquaculture production. Other stakeholders include private, state, and federal fish hatcheries as well as game and fish scientist and managers. Our laboratory provides diagnostic services to aquaculture producers. The target audience benefited from timely and accurate disease diagnostics, and the ability to obtain medicated feed either the same or next day. This was achieved by having a workshop to explain the process. Annually, we survey the producers to determine which diseases are most problematic. We work with USDA ARS scientist to address the vaccine development for those disease. Research conducted has included examining disease resistance to the three FDA approved antibiotics by conducting antibiotic disk tests and MIC plates. We have conducted workshops on the identification of diseases and the use of the veterinary feed directive to obtain medicated feed.

Based on producer input, a winter feeding study for channel catfish was conducted at the E.W. Shell Fisheries Research Station and on a farm in west Alabama to compare the immune response in fish fed either a 28% or 32% protein feed at two different feeding regimes. This study provided producers with information on improving the ability of fish to resist disease when coming out of winter.

Research examining probiotics in feeds and the effects on the immune system have also been conducted. Two of the probiotics are showing increased immune response and growth as well as a reduction in feed conversion efficiency.

Several publications and other products were produced for the benefit of the target audience during the past year:

Peer reviewed journal articles:

Tuttle, J.T., M.A. Smith, L.A. Roy, M. Jones, R. Lochmann, and A.M. Kelly, 2022. Effects of different feeding regimes on growth rates and fatty acid composition of largemouth bass *Micropterus nigricans* at high water temperatures. *Animals* **2022**, 12, 2797. <https://doi.org/10.3390/ani12202797> (Invited)

Kaimal, S., B.D. Farmer, N. Renukdas, H. Abdelrahman, and A.M. Kelly. 2022. Evaluating stress-mediated microbial pathogenesis in Golden Shiners, *Notemigonus crysoleucas*. *Frontiers in Physiology*. Volume 13. Article 886480. doi: 10.3389/fphys.2022.886480 (Invited)

Kaimal S., Haukenes A., Renukdas N., Kelly AM. 2022. Effects of crowding and water flow on golden shiners, *Notemigonus crysoleucas*, held in a flow tank. *Frontiers in Physiology*. Volume 13, Article 875898. doi: 10.3389/fphys.2022.875898 (Invited)

Roy, L.A., S.D. Rawles, H.E. Quintero, A.M. Kelly, J. Park, C.D. Webster. 2022. Weight loss, survival, and fatty acid composition in over-wintered juvenile Coppernose Bluegill (*Lepomis macrochirus purpureus*) cultured in outdoor tanks using different feeding regimens. *North American Journal of Aquaculture*, 45-52. <https://doi.org/10.1002/naaq.10213>

Extension Articles

Galkanda-Arachchige J, Davis DA, Kelly AM, Roy LA. 2022. Low-cost salt mixtures serve as an alternative to reconstituted sea salts during low salinity acclimation of Pacific white shrimp. *Alabama Cooperative Extension Fact Sheet*. ANR-2785. 4pp.

Roy, L., T., Bruce, A. Kelly, and D.A. Davis. 2022. Grant dollars secured to study the impact of high water temperature on growth, digestibility, and immune parameters of channel and hybrid catfish fed different plant and animal protein diets. Fish Farming News. 2022(2):14.

Tuttle, J., T. Bruce, I. Butts, L. Roy, B. Beck, and A. Kelly. 2022. Does virulent aeromonas hydrophila remain in soils? Fish Farming News. 2022(2):12-13.

Oladipupo, A., A. Kelly, A. Davis, L. Fantini Hoag, and T. Bruce. 2022. Evaluating new dietary additives for promoting healthy channel catfish production. Fish Farming News. 2022(2):10-11.

Kelly, A., L. Roy, J. James, H. Abdelrahman, S. Marsh, and J. Tomasso. 2022. Physiological effects of commercial harvest and transport of hybrid catfish during warmer and colder months. Fish Farming News. 2022(2):8-9.

Kelly, A. 2022. How accurate is your fingerling inventory? Fish Farming News. 2022(2):7.

Roy, L., A. Kelly, S. Dahl, J. James, and T. Hanson. 2022. Elevated water temperatures observed in commercial catfish ponds in 2022 compared to 2021. Fish Farming News. 2022(2):6.

Kelly, A. and L. Roy. 2022. Ammonia in catfish ponds. Fish Farming News. 2022(2):4-5.

Wang, H., Sheng, L., Li, X., Yazdi, Z., Abdelrahman, H., Roy, L., Kelly A., Soto Martinez E., and Wang, L. 2022. Effect of antibiotics on gut bacteria and antibiotic-resistant genes in channel catfish. Fish Farming News. 2022(1):15.

Roy, LA, J Palmer and A.M. Kelly. 2022. Monitoring historically problematic blue-green algae ponds in the spring can be beneficial for commercial catfish producers. Fish Farming News. 2022(1):9-10.

In addition to the above, 22 conference abstracts were produced.

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

The broader public benefited from this project's activities by sustainable production of safe seafood products for human consumption. Recreational anglers benefited from techniques devised that reduced disease and increased production of commercial species for stock enhancement, conservation or recreational fisheries purposes.

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 plan is to continue the approach and methods outlined in the original proposal, therefore no major changes to the project goals, objectives or direction have occurred. Several peer reviewed publications are in the process of review and hopefully published from this last period as well. Efforts to obtain intramural and extramural funds to support this research program will be continued.

Sustainable Meat Packaging Systems for Red Meat

Project Director

Jason Sawyer

Organization

Auburn University

Accession Number

1023011



Vacuum Packaging Fresh and Frozen Red Meats

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

The meat industry produces over 103.3 billion pounds of beef, chicken, goat, lamb and pork annually. With over 133 billion pounds of food wasted each year in the United States, 30% of that is attributed to meat products. Consumer packaging of fresh meat today is comprised of multiple forms that include Poly-Vinyl Chloride (PVC), Modified Atmosphere (MAP), Vacuum-Skin (VSP), or Rollstock (RS) packaging method. Within these methods are multiple iterations and modifications to the method but packaging is ultimately designed around the consumer and their purchasing intent. With excessive waste of meat and food products occurring due to shelf life deterioration, and millions of pounds of meat products produced in Alabama annually there is need for further investigation of sustainable meat packaging. Current packaging methods utilized in the retail sector for fresh meat are comprised of an expanded poly-styrene tray and meat is covered with a polyvinyl chloride film. This method allows the greatest quantity of oxygen to reach the cut surface of the meat whereby changing the meat surface color to the preferred consumer color of red. Identifying unique packaging methods that limit oxygen exposure, preserve the surface color and can provide enhancements to tenderness and flavor would be preferred. In addition, inclusion of newer technology could provide consumers with friendly methods of storing meat products for extended periods. Results from these projects would be disseminated through peer-reviewed scientific journals, webinars, social media outlets and educational meetings for stakeholders. Furthermore, these results will enhance the meat production industry throughout Alabama and more importantly the nation. It will lend to improvements of meat storage and packaging methods that will further enhance consumer acceptance of red meat proteins, in addition to creating a more sustainable meat packaging platform.

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.

Evaluating these objectives, researchers have conducted countless studies lasting from 5 to 35 days in length evaluating fresh and frozen red meat products. These efforts have identified the “best” performing packaging films for use in both fresh and frozen beef steaks, ground beef and even goat meat products. Packaged samples were evaluated daily for changes in surface color, pH, microbial spoilage, instrumental color measurements, and lipid oxidation. Results from these projects suggest that variations in packaging films will impart variations in the longevity of the packaged meat stored in the retail setting. Color variations on the surface of the meat product has been reported to influence consumer purchasing decisions. Through these projects we have identified packaging materials that can potentially provide additional support of meat packaging at the retail/consumer level. Additional investigations are needed to evaluate additional implications of duration (length) of storage ability, and gas influencers within the packaging platforms. Investigation of surface color by trained and untrained sensory panelists will be vital in the identification of an optimal packaging material/platform for fresh and frozen beef steaks or ground beef in a consumer setting. In addition, research on sensory profiles of these protein products will be addressed in subsequent testing to evaluate any issues with alternative packaging methods.

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

Throughout this objective of the project for research mentoring and training, four graduate students (M.S.) have been guided on the path of designing, conducting, and analyzing research results focused on meat product packaging. Three of the graduate students have successfully completed degree requirements during this time and successfully graduated from the department of animal sciences. Additional undergraduate and graduate students have been trained on sourcing raw materials, operation of packaging equipment, operation of grinding and portioning equipment and sanitation of processing facility prior to and immediately after production of research samples. In addition, graduate students have been trained in applied analytical methods for measuring meat quality such as applied microbial analysis, instrumental color, pH, near-infrared spectroscopy measurement (FOSS), trained color analysis, and lipid oxidation (TBARS). Undergraduate students participating in the project arena have been trained in applied meat equipment operations and scientific data collection. Undergraduate student assistants with this project are students under recruitment for graduate school to further enhance the study of red meat science and implications of packaging on meat products for the consumer.

Results from the current objectives have been disseminated as referred journal articles and citations are listed below. In addition, results have been formatted for departmental extension reports to be published in an online format during 2023.

1. M. P. Wagoner, T. M. Reyes, V. E. Zorn, M. M. Coursen, K. E. Corbitt, B. S. Wilborn, C. W. Starkey, T. D. Brandebourg, A. D. Belk, T. Bonner and **J. T. Sawyer**. Vacuum packaging maintains fresh characteristics of previously frozen beef steaks during simulated retail display. *Foods*. 11(19), 3012. <https://doi.org/10.3390/foods11193012>
2. M. P. Wagoner, T. M. Reyes, V. E. Zorn, M. M. Coursen, K. E. Corbitt, B. S. Wilborn, T. D. Brandebourg, A. D. Belk, T. Bonner, and **J. T. Sawyer**. 2022. Influence of vacuum packaging on instrumental surface color characteristics of frozen beef

3. R. Gurung, K. Ale, F. W. Abrahamsen, K. Moyer, **J. T. Sawyer**, N. K. Gurung. 2022. Carcass traits of growing meat goats fed different levels of hempseed meal. *Animals*. 12(15), 1986. <https://doi.org/10.3390/ani12151986>
4. T. M. Reyes, M. P. Wagoner, V. E. Zorn, M. M. Coursen, B. S. Wilborn, T. Bonner, T. D. Brandebourg, S. P. Rodning, and **J. T. Sawyer**. 2022. Vacuum packaging can extend fresh color characteristics of beef steaks during simulated display conditions. *Foods*. 11(4), 520. <https://doi.org/10.3390/foods11040520>
5. T. M. Reyes, H. R. Smith, M. P. Wagoner, B. S. Wilborn, T. Bonner, and **J. T. Sawyer**. 2021. Surface color variation of ground beef packaged using Enhanced, Recycle Ready, or Standard Barrier Vacuum Films. *Foods*. 11(2), 162. <https://doi.org/10.3390/foods11020162>.
6. H. R. Smith, B. S. Wilborn, A. G. Parnell, T. M. Reyes, M. P. Wagoner, L. E. Yoder, E. Blythe, D. R. Mulvaney, S. P. Rodning, M. K. Mullenix, T. Bonner, and **J. T. Sawyer**. 2021. Impact of packaging film and beef trimmings on ground beef shelf life. *Foods*. 10(8), 1923. <https://doi.org/10.3390/foods10081923>

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

Results presented in referred journal articles are available through open-access to all meat and food industry affiliations to adopt and utilize for improving production practices of meat and food products. Industry adoption of new technologies such as packaging are always evolving to enhance the duration and safety of stored food products. The results generated through these projects can be instrumental in providing some of the fastest solutions to solving the food waste issues this country and the globe face. Additional research with new graduate student recruitments will be focused on the logistical inclusion of vacuum packaged fresh and frozen meats. Researchers will enhance the investigation through sensory taste panel analysis. In addition, further research will evaluate extension of storage periods outside of traditional storage timelines that exceed 60 days of storage. Furthermore, new packaging technology is evolving, and graduate student researchers will be evaluating cook-in package approaches in addition to flow-wrapping (gas packaging).

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

A major goal of this project is to enhance red meat packaging platforms for the meat industry. These forms of packaging can provide meat products with longer storage periods, greater consumer acceptability and created from materials that are accepted within the recyclable streams. The following project objectives have been created to address the overarching goals of this project.

1. Evaluation of packaging films for fresh and frozen red meat formulations for use in case-ready applications.
2. Understand the influence of red meat sources on packaging materials and shelf life for case-ready applications.
3. Identify the influence of packaging materials on extended aging and sensory taste profiles.
4. Evaluate the impact of new technologies (flow-wrapping) on fresh beef.
5. Training of additional undergraduates, graduate, and international research scholars on fresh and frozen red meat packaging technologies.

Aquaculture Production Techniques for Aquatic Species in Warmwater and Low Salinity Water of West Alabama

Project Director

Luke Roy

Organization

Auburn University

Accession Number

1019459



Aquaculture Production Techniques for Aquatic Species in Warmwater and Low Salinity Water of West Alabama

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

This project addresses the optimization of aquaculture production practices for warmwater and marine species with a particular emphasis on commercial aquaculture species raised in Alabama including channel catfish, hybrid catfish, tilapia, crawfish, largemouth bass, bluegill, redear sunfish, crappie, grass carp, baitfish, marine shrimp, and other euryhaline species of interest.

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

Research carried out during this project year helped advance our knowledge of improved aquaculture production practices and techniques with the end goal of improving performance and financial sustainability of aquaculture operations in Alabama and the Southeastern U.S. Aquaculture production research was carried out on catfish, largemouth bass, shrimp, and crawfish, which are all important commercial species in Alabama. Research carried out on production practices and management (catfish aging of carryover fish / winter feeding strategies), water quality, and harvest techniques of catfish, crawfish, and largemouth bass has provided new knowledge to commercial aquaculture producers raising these species. Likewise, shrimp farmers have benefited tremendously from research carried out in this period that has focused on production techniques (ion supplementation), water quality (ionic profiles and alternative salt mixtures), shrimp health, and alternative feeding technology (commercial feed demonstrations). Collectively, this stakeholder driven research has addressed difficult questions posed by the aquaculture industry through applied research and Extension activities, many of which were carried out on real commercial farms.

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

The target audience reached through project efforts includes catfish farmers, catfish processors, feed mills, harvest crews, other stakeholders associated with the Alabama catfish industry, shrimp farmers, crawfish farmers, catfish farmers seeking to diversify, and other stakeholders associated with the inland low salinity aquaculture industry in Alabama. Other stakeholders include private, state, federal hatcheries as well as game and fish scientists and managers. The target audience benefited from the development and testing of new aquaculture production techniques and practices for commercial aquaculture species of interest in Alabama and the Southeastern region. During the reporting period, an electrofishing study was carried out on commercial catfish farms to quantify the size structure of carryover fish in hybrid catfish ponds. This study provided commercial producers with valuable information related to the age of carryover catfish in their ponds which is an indirect measure of seining efficiency. Following producer input, a winter feeding study was carried out on a farm in west Alabama and at the E.W. Shell Fisheries Research Station to compare the performance of 28% and 32% protein feeds and two different feeding regimes. This study provided commercial producers with timely and practical information related to winter feeding of their catfish in terms of performance and cost. A study was completed on the influence of aqueous magnesium on shrimp production in low-salinity water. Information from this particular study was valuable to commercial shrimp producers contemplating adding additional magnesium to commercial ponds as a means to increase growth, survival, and production. A commercial feed demonstration study was carried out on a shrimp farm in Florida to evaluate new automated feeding technology. This feeding study demonstrated more efficient feeding technology to commercial shrimp producers that should help improve profitability and sustainability.

Besides these projects, support was provided to over a dozen additional projects via collaboration between my laboratory and other faculty collaborators at Auburn and other institutions that directly benefited stakeholders and consumers of the aquaculture industry.

A number of publications and other products were produced for the benefit of the target audience during this reporting period:

Journal Articles & Book Chapters:

Hegde S*, Kumar G, Engle C, Hanson TA, **Roy LA**, van Senten J, Johnson J, Avery J, Aarattuthodi S, Dahl S, Dorman L, Peterman M. 2022. Economic impact assessment of the U.S. catfish industry. *Aquaculture Economics and Management*. 26(4):384-414.

Tuttle JT*, Smith MA, **Roy LA**, Jones M, Lochmann R, Kelly AM. 2022. Effects of different feeding regimes on growth rates and fatty acid composition of largemouth bass *Micropterus nigricans* at high water temperatures. *Animals*. 2022 (12):2797.

Hegde S*, Kumar G, Engle C, Hanson TA, **Roy LA**, Cheatham M*, Avery J, Aarattuthodiyil S, van Senten J, Johnson J, Wise D, Dahl S, Dorman L, Peterman M. 2022. Technological progress in the U.S. catfish industry. *Journal of the World Aquaculture Society*. 53:367-383.

Pattillo DA*, Hager JV, Cline DJ, **Roy LA**, Hanson TR. 2022. System design and production practices of aquaponic stakeholders. *PLoS ONE*. 17(4):e0266475.

Roy LA, Rawles SD, Quintero HE, Kelly AM, Park J, Webster CD. 2022. Weight loss, survival, and fatty acid composition in overwintered juvenile Coppernose Bluegill (*Lepomis macrochirus purpureus*) cultured in outdoor tanks and fed different feeding regimens. *North American Journal of Aquaculture*. 84(1):42-52.

Pattillo DA*, Cline DJ, Hager JV, **Roy LA**, Hanson TR. 2022. Challenges experienced by aquaponic hobbyists, producers, and educators. *Journal of Extension* 60(4): Article 13. <https://doi.org/10.34068/joe.60.04.13>

Reis J*, Quintero HE, **Roy LA**. 2022. Feeding practices for automated systems. Chapter 13, Pages 57-73 in: *The Shrimp Book*. Volume 2. V. Alday-Sanz, Editor. 5m Publishing. Sheffield, UK. 660 pp. (invited contribution)

Extension Articles and Popular Articles

Weldon A, Davis DA, **Roy LA**. 2022. Shrimp in Alabama. *Alabama Cooperative Extension Fact Sheet*. ANR-1028. 4pp. <https://www.aces.edu/blog/topics/coastal-programs/shrimp-in-alabama/>

Galkanda-Arachchige H, **Roy LA**, Kelly AM, Davis DA. 2022. Low-cost salt mixture can replace expensive, reconstituted sea salts in inland low salinity shrimp farming. *Global Seafood Alliance*. [Can a low-cost salt mixture replace sea salts for low-salinity shrimp farming? - Responsible Seafood Advocate \(globalseafood.org\)](https://www.globalseafood.org/can-a-low-cost-salt-mixture-replace-sea-salts-for-low-salinity-shrimp-farming?)

Kumar G, Avery J, Hegde S*, Aarattuthodi S, Engle C, Hanson T, **Roy LA**, Dahl S, van Senten J, Johnson J, Dorman L, Peterman P. 2022. New study shows industry economic impact near \$2 billion. *The Catfish Journal* 36(1):8, 23.

Roy L. 2022. Dr. Terry Hanson retires from the School of Fisheries, Aquaculture, and Aquatic Sciences. Alabama Cooperative Extension Newsletter. *Fish Farming News*. 2022(2):3-4.

Kelly A, **Roy L**. 2022. Ammonia in catfish ponds. Alabama Cooperative Extension Newsletter. *Fish Farming News*. 2022(2):4-5.

Roy L, Kelly A, Dahl S, James J, Hanson T. 2022. Elevated water temperatures observed in commercial catfish ponds in 2022 compared to 2021. Alabama Cooperative Extension Newsletter. *Fish Farming News*. 2022(2):6-7.

Kelly A, **Roy L**, James J, Abdelrahman H, Marsh S, Tomasso J. 2022. Physiological effects of commercial harvest and transport of hybrid catfish during warmer and colder months. Alabama Cooperative Extension Newsletter. *Fish Farming News*. 2022(2):8-9.

Tuttle J*, Bruce T, Butts I, **Roy L**, Beck B, Kelly A. 2022. Does virulent *Aeromonas hydrophila* remain in soils? Alabama Cooperative Extension Newsletter. *Fish Farming News*. 2022(2):12-13.

Roy L, Bruce T, Kelly A, Davis DA. 2022. Grant dollars secured to study the impact of high-water temperature on growth, digestibility, and immune parameters of channel and hybrid catfish fed different plant and animal protein diets. Alabama Cooperative Extension Newsletter. *Fish Farming News*. 2022(2):14.

Engle C, Kumar G, Christie T, Dorr B, Davis B, **Roy L**, Kelly A. 2022. Economics of cormorant predation on catfish farms. *NWAC News* 17(1):4-5.

Wang H, Sheng L, Li X, Yazdi Z, Abdelrahman H, **Roy LA**, Kelly A, Martinez ES, Wang L. 2022. Effect of antibiotics on gut bacteria and antibiotic-resistant genes in channel catfish. Alabama Cooperative Extension Newsletter. *Fish Farming News*. 2022(1):15.

Roy LA, Palmer J*, Kelly A. 2022. Monitoring historically problematic blue-green algae ponds in the spring can be beneficial to commercial catfish producers. Alabama Cooperative Extension Newsletter. *Fish Farming News*. 2022(1):9-10.

In addition to these products 18 conference abstracts were produced in 2022.

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

The broader public benefited by my project's activities via the sustainable production of safe seafood products for human consumption. In addition, recreational anglers benefited from aquaculture techniques developed to optimize production practices of commercial species grown for stock enhancement or recreational fishing purposes.

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.

During the next reporting period the plan is to follow the approach and methods as outlined in the original 5 year proposal (2019-2024). Hence, no major changes to the project objectives, goals, and direction have occurred. There are a number of peer-reviewed journal publications that are being prepared to publish work from this past project period. Efforts will continue to secure intramural and extramural funds to support this research program. On-farm research and demonstration projects will be implemented in the next year of the project including experiments and on-farm demonstrations with marine shrimp, catfish, largemouth bass, and crawfish.

Closing Out (end date 03/06/2024)

Noncoding RNA-protein complexes as targets for developing novel therapeutic agents against domesticated animal and human pathogens

Project Director

Jacek Wower

Organization

Auburn University

Accession Number

1018885



Non-coding RNA-protein complexes as targets for developing novel therapeutic agents domesticated animals and human pathogens

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

I am pushing the boundaries of science to develop life-changing medicines and methods for their delivery. Identifying and characterizing drug targets constitute an essential step in developing the next generation of therapeutics for human and animal diseases that were previously difficult to prevent and cure. The therapeutic efficacy of the drug is affected by drug delivery approaches. Therefore, my research also focuses on developing drug delivery systems that will minimize the side effects of the therapy even when I deliver large drug payloads to diseased tissues.

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 2022, I focused my research on (a) characterizing the structure of an RNA pseudoknot that constitutes an attractive target for small molecule drugs against bovine viral diarrhea virus (BVDV) and (b) building novel platforms for controlled drug delivery to diseased tissues.

(a) Structural analysis of the Bovine Viral Diarrhea Virus Internal Ribosome Entry Site

BVDV is a member of the genus *Pestivirus*, family Flaviviridae, which includes the causative agents of economically significant diseases of cattle, pigs, and sheep. Its genome is a positive-sense single-stranded RNA that codes for one open reading frame (ORF). The coding region is preceded by the distinctly structured 5'-untranslated region (5'-UTR), which folds into the Internal Ribosomal Entry Site (IRES). By definition, IRES is the RNA domain that recruits ribosomes to the internal region of mRNAs to initiate the translation of the viral RNA genome.

Disrupting the IRES RNA structure or preventing the binding of translation factors to the IRES RNAs abolishes BVDV replication. I focused my research on a pseudoknot structure located in the middle section of the Internal Ribosomal Entry Site (IRES). Using various biochemical methods, researchers demonstrated that the integrity of the RNA pseudoknot is essential for BVDV replication. Therefore, the RNA pseudoknot constitutes an attractive target for therapeutic intervention.

The lack of high-resolution structural data for BVDV IRES RNA constitutes a significant obstacle to developing effective antivirals against Bovine Viral Diarrhea disease. In my recent work, I collected BVDV IRES RNA sequences from GenBank and Rfam and used rigorous comparative sequence analysis to determine a phylogenetically supported RNA secondary structure. I then used this structure to construct the first low-resolution three-dimensional model of the BVDV IRES RNA. I considered experimental data from the related IRES RNAs if no corresponding information was available for the predicted BVDV structure. The results provided a foundation for the development of the high-resolution structure of the RNA pseudoknot that is essential for BVDV replication. Finally, I probed the in vivo synthesized BVDV IRES RNA using the SHAPE-MaP method. **The data derived by SHAPE-MaP experiments provided a fine-grained picture of the tertiary structure of the functionally important BVDV pseudoknot.**

(b) Nanoparticles as novel platforms for controlled drug delivery to diseased tissues

Nanoparticles offer significant advantages over conventional drug delivery in terms of high stability, high specificity, high drug-carrying capacity, the ability for controlled release, possibility to use in different routes of administration, and the capability to deliver both hydrophilic and hydrophobic drugs. Technological advancements in nanotechnology and nucleic acid chemistry were instrumental in developing highly effective mRNA COVID vaccines. However, recent developments demonstrate that, vaccines alone will not get us out of the COVID. One can also assume that vaccines alone will not be able to eradicate the Bovine Viral Diarrhea disease.

Many side effects can be mitigated by controlled drug delivery. Such delivery can be achieved using nanocarriers with highly controllable therapeutic delivery. To construct such nanocarriers, I took advantage of the DNA-gated mechanism by which DNA oligonucleotides physically block the release of encapsulated drugs from porous nanoparticles. I extended this mechanism to be used with drugs bound to the surface of DNA-capped gold nanoparticles (AuNPs). I investigated DNA monolayers of different thicknesses and hybridization states to determine how DNA surface architecture can affect the release of a template drug bound to the gold surface. DNA layers were investigated on a planar gold surface via quartz crystal microbalance with dissipation and on AuNPs via dynamic light scattering (DLS). I observed that varying DNA architectures on AuNPs results in different release rates of the drug. The rate of drug release can be slowed by using either folded or randomly coiled DNA strands, which act as a physical barrier to diffusion. When long single-stranded DNA (ssDNA) is used, the drug release is slowed even further. Monolayers with vertical DNA strand orientation release drug quickly. However, even vertical DNA layers prevent drug diffusion at longer sequence lengths. I hypothesize that the architecture of the DNA layer, influenced by the folded or vertical orientation of individual DNA molecules, affects the free diffusion of drugs away from the AuNP surface. This mechanism may improve the biological availability of many surface-bound drugs on DNA-capped nanoparticles. **The DNA-capped AuNPs offer a novel method for alleviating side effects caused by antivirals and anti-cancer drugs.**

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

My primary target is a worldwide network of researchers and students who search for novel therapeutics against human and animal pathogens.

The project involves collaboration with Drs. Joanna Sztuba-Solinska (Department of Biological Sciences, Auburn University) and Mark E. Byrne (Virtual School of Translational Biomedical Engineering & Sciences at Rowan University). Interactions between researchers and students from these laboratories provided unique opportunities to enhance practical skills and

professional networking. Our students had an excellent opportunity to improve their writing skills as they were actively engaged in the preparation of manuscripts that we published in two peer-reviewed journals. Moreover, our students had an opportunity to present their research at the national meeting.

Publications:

Gosavi D, Wower I, Beckmann IK, Hofacker IL, Wower J, Wolfinger MT, Sztuba-Solinska J. Insights into the secondary and tertiary structure of the Bovine Viral Diarrhea Virus Internal Ribosome Entry Site. *RNA Biol.* 2022;19(1):496-506. doi: 10.1080/15476286.2022.2058818. Epub 2021 Dec 31. PMID: 35380920; PMCID: PMC8986297.

Robert J. Mosley, Julia Hart, Kadie L. Davis, Jacek Wower, Mark E. Byrne. (2022) Tailored Nucleic Acid Architectures at Gold Surfaces for Controlled Therapeutic Release. *Langmuir* 2022 Jan 24. doi: 10.1021/acs.langmuir.1c02718. Epub ahead of print. PMID: 35073106.

Robert J Mosley, Kadie L Davis, Ashleigh Jankowski, Jacek Wower, Mark E Byrne Near zero-order release of daunomycin from engineered nucleic acid monolayers. (2022) *Advanced Therapeutics*, submitted.

Conference Presentations:

M. V. Talarico, J. Wower, M.E. Byrne. Theophylline-Selective Riboswitch for the Controlled Release of Intercalated Daunomycin. 2021 American Institute of Chemical Engineering (AIChE) Annual Meeting, Poster Session, Boston, MA, USA, November 16, 2021.

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

Bovine viral diarrhea virus (BVDV) is a significant pathogen causing up to \$2.5 billion per year in economic losses worldwide. In the United States, losses range between \$35 and \$56 million per million calves born. Due to the nature of viral infections, there is no treatment to cure an animal of a viral infection fully. Numerous vaccination practices against BVDV infection have been proposed, yet with limited success. While killed BVDV vaccines provide the greatest safety, their limited immunogenicity makes multiple vaccinations necessary. In contrast, modified-live viral (MLV) vaccines induce a broader range of immune responses but require strategic vaccination to minimize potential risks. Thus, my research addresses a major challenge in agriculture. **My successful structural analysis of the BVDV IRES RNA will facilitate the rational design of anti-BVDV drugs. It may also significantly impact animal protein production, biosecurity, animal welfare, agricultural water uses, and environmental protection.**

I showed that tailoring nucleic acid architectures on nanoparticle surfaces can be used to achieve the controlled, DNA-gated release of bound molecules. I expect that my nano platform could be extended for the sustained release of a wide variety of molecules, including surface-bound therapeutics. The programmable nature of DNA nanostructures also provides an avenue toward selective targeting or triggered release mechanisms, adding to the multifunctionality of this nanocarrier. **I envision that effective dual-release nanocarriers, which can control the release of intercalated and surface-bound therapeutics, will revolutionize personalized disease treatments.**

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.

Future plans:

I will continue my search for antivirals against SARS-CoV-2. RNA-binding proteins nsp7, nsp8, nsp12, nsp13, and nsp15 will be my primary targets.

I will search for small molecules that can bind to BVDV IRES RNA and inhibit BVDV replication.

Comparative and functional genomics, epigenomics and metagenomics in food animal health

Project Director

Xu Wang

Organization

Auburn University



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

Meat, eggs, and dairy are animal-based food that account for 68% of the protein source in human nutrient. Improving the health and production of livestock animals in a sustainable manner will not only maintain an abundant supply of food source but also enhance the human health.

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

To achieve this goal, I will exploit cutting-edge genomics and bioinformatics approaches to understand the genome, epigenome and gut microbiome in 1) food production animals including cattle, pig, chicken, and catfish, 2) pest insect and invertebrate species of agriculture importance, 3) biological control agent for pest management such as parasitoid jewel wasps, and 4) viruses and microbes which are pathogenic to animals and humans.

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

The target audiences include 1) scientists and researchers in academia who are interested in genetic, epigenetic basis of animal disease and animal health, 2) livestock industry and farms in need of effective chemical and biological control for agriculture pests and knowledge to enhance the animal health and improve the production efficiency, 3) policy makers and funding agencies who highly value the research of sustainable and environmental friendly approaches for pest control and food animal production.

As the largest aquaculture industry, catfish farming accounts for 70% of total US freshwater production. The hybrid of female channel catfish and male blue catfish (*Ictalurus punctatus* × *I. furcatus*) is superior in growth and disease resistance due to heterosis. More than 50% of the total harvest is from hybrid production, and the number is still increasing. The channel catfish genome has been published in 2016, but the blue catfish genome was not available. Further genetic improvement of the hybrid catfish breed is hindered by the lack of a blue catfish reference genome. We reported the first high-quality, chromosome-level assembly of the blue catfish genome, which provides the necessary genomic tool kit for SNP discovery and marker-assisted selection, gene editing and genome engineering, as well as reproductive enhancement of the blue catfish and hybrid catfish.

Although hybrid catfish has the best growth performance in earthen pond, channel catfish grow faster in tank units of smaller size, indicating that the hybrid vigor is environment-dependent. To investigate the mechanisms of this phenomenon, hematological assays and transcriptome analysis were performed in the parental species and hybrid crosses. Lower levels of innate immunity activity, stress, as well as lowered blood glucose/lactate was found in channel catfish, which are associated with superiority in growth. Functional enrichment analysis revealed that genes involved in fatty acid metabolism/transport pathways are significantly upregulated in channel catfish. The results provide insights into the molecular mechanisms of hybrid vigor and will inform the development of new strategies for genetic enhancement through hybrid breeding.

A major challenge in hybrid catfish breeding is that hybrids can rarely be naturally spawned. Sperm collection is a lethal procedure, and variation in sperm quality causes variable embryo hatch rates, which is the limiting factor in hybrid catfish breeding. Cryopreservation of high-quality sperm can meet the fertilization needs. Biomarkers as indicators for sperm quality and reproductive success are currently lacking. To address this, we investigated expression changes caused by cryopreservation using transcriptome profiles of fresh and cryopreserved sperm. Sperm quality measurements revealed that cryopreservation significantly increased oxidative stress levels and DNA fragmentation, and reduced sperm kinematic parameters. RNA-seq study identified 849 up-regulated genes after cryopreservation, including members of all five complexes in the mito-chondrial electron transport chain, suggesting a boost in oxidative phosphorylation activities, which often lead to excessive production of reactive oxygen species associated with cell death. Interestingly, functional enrichment analyses revealed compensatory changes in gene expression after cryopreservation to offset detrimental effects of ultracold storage: MnSOD was induced to control ROS production; chaperones and ubiquitin ligases were upregulated to correct misfolded proteins or direct them to degradation; negative regulators of apoptosis, amide bio-synthesis, and cilium-related functions were also enriched. Our study provides insight into underlying molecular mechanisms of sperm cryoinjury and lays a foundation to further explore molecular biomarkers on cryosurvival and gamete quality.

Peer-reviewed scientific publications resulted from the hatch support:

- Patel P, Selvaraju V, Babu JR, **WangX**, and Thangiah G (2022). Racial Disparities in Methylation of NRF1, FTO, and LEPR gene in Childhood Obesity. *Genes*, 13(11):genes13112030. <https://doi.org/10.3390/genes13112030>
- Xie Q, Zhan W, Shi Z, Liu F, Niu B, He X, Liu M, Liang Q, Xie Y, Xu P, **WangX**, and Lou B (2022). Whole-genome assembly and annotation of little yellow croaker (*Larimichthys polyactis*) provide insights into hermaphroditism and gonochorism evolution. *Molecular Ecology Resources*, 10.1111/1755-0998.13731. <https://doi.org/10.1111/1755-0998.13731>
- Luo Y, Woodie LN, Graff EC, Zhang J, Flowers S, Wang XZ, **WangX**, O'Neill AM, and Greene MW (2022). Role of liquid fructose/sucrose in regulating the hepatic transcriptome in a high-fat Western diet model of NAFLD. *Journal of Nutritional Biochemistry*, 112, 109174. <https://doi.org/10.1016/j.jnutbio.2022.109174>
- Ma X, Brinker E, Cao W, Graff EC, and **WangX** (2022). Effect of mineral oil as a lubricant to collect feces from cats for microbiome studies. *Journal of Veterinary Internal Medicine*, 36(6):1974-1980. <http://doi.org/10.1111/jvim.16556>
- Wang H, Montague RH, Hess NH, Zhang Y, Dunham RA, Butts IAE, and **WangX** (2022). Transcriptome analysis reveals key gene expression changes in blue catfish sperm in response to cryopreservation. *International Journal of Molecular Science*, 23(14):7618. <https://doi.org/10.3390/ijms23147618>
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- Abass N, Simora RM, Wang J, Li S, Su B, Xing D, Coogan M, Johnson A, Creamer D, **WangX**, and Dunham RA (2022). Response of cecropin transgenesis to challenge with *Edwardsiella ictaluri* in channel catfish *Ictalurus punctatus*. *Fish and Shellfish Immunology*, 126:311-317. <https://doi.org/10.1016/j.fsi.2022.05.050>
- Ma X, Brinker E, Graff EC, Cao W, Gross AL, Johnson A, Zhang C, Martin D, and **WangX*** (2022). Whole-genome shotgun metagenomic sequencing revealed distinct gut microbiome signatures of obese cats. *Microbiology Spectrum*, 10(3):e00837-22. <https://doi.org/10.1128/spectrum.00837-22>
- Zhou Y, Wang Y, Xiong X, Appel A, Zhang C*, and **WangX*** (2022). Profiles of telomeric repeats in Insecta reveal diverse forms of telomeric motifs in Hymenopterans. *Life Science Alliance*, 5(7):e202101163. <https://doi.org/10.26508/lsa.202101163>
- Wang H, Bruce T, Su B, Li S, Dunham RA, and **WangX*** (2022). Environment-dependent heterosis and transgressive gene expression in reciprocal hybrids between the channel catfish *Ictalurus punctatus* and the blue catfish *Ictalurus furcatus*. *Biology*, 11(1), 117. <https://doi.org/10.3390/biology11010117>
- Patel P, Babu JR, **WangX**, and Thangiah G (2022). Role of Macronutrient Intake in the Epigenetics of Obesity. *Biochemical Society Transactions*, BST20211069. <https://doi.org/10.1042/BST20211069>
- Xiong X, Samollow PB, Cao W, Metz, R, Zhang C, Leandro AC, VandeBerg JL, and **WangX***. (2022). Genetic and genomic architecture in eight strains of the laboratory opossum *Monodelphis domestica*. *Genes, Genomes, Genetics*, 12(1), jkab389. <https://doi.org/10.1093/g3.journal/jkab389>

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

Our research significantly advanced the knowledge in hybrid catfish genetics and reproduction, which will lead to improve production. Catfish accounts for over 70% of the US aquaculture and the boarder publish will benefit from the adequate supply of animal proteins.

Alternative Forage Systems for the Southeastern U.S.

Project Director

Sandra Dillard

Organization

Auburn University

Accession Number



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

Results will be used enhance the environmental and economic sustainability for forage-based livestock production in Alabama, and throughout the Southeast. Knowledge gained from this project will be used to assist Alabama forage livestock producers overcome the challenges of higher input costs, pest pressure, and changing climatic conditions

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

During the FY 2022, two major components of this HATCH project were completed. This included the 4-year evaluation of grazing cover crops in a cotton-peanut rotation and the use of plant growth-promoting rhizobacteria (PGPR) evaluation in bermudagrass pasture and hay fields. Both projects assisted myself and other Extension professionals in being able to better determine management of cover crops and cattle when grazing cover crop mixtures. We were also able to better inform producers on how PGPR can be used to reduce N fertility needs of bermudagrass.

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

Outputs from this year included several peer-reviewed journal articles, abstracts and conference proceedings, as well as peer-reviewed Extension publications.

Peer-reviewed Journal Articles:

1. Shoup, S.L. *, R.B. Muntifering, M.K. Mullenix, L.S. Silva, and S.L. Dillard. 2022. In situ ruminal digestion, fermentation parameters, and forage nutritive value of cool-season baleage ensiled under contrasting inoculant strategies. *Animals*. 12:21 (2929). Doi: 10.3390/ani12212929
2. Yin, J., D.M. Martinez, M.F. Chamorro, S.L. Dillard, and R. Cattley. 2022. Naturally occurring senna plant toxicity in an Angus cross calf. *Veterinary Record Case Reports* 22:e442. Doi:10.1002/vrc2.442
3. Mocniak, L., K.R. Elkin, S.L. Dillard, R.B. Bryant, and K.J. Soder. 2022. Building comprehensive glucosinolates profiles for brassicas varieties. *Talanta: The International Journal of Pure and Applied Analytical Chemistry*. 251:123814. Doi:10.1016/j.talanta.2022.123814

Peer-reviewed Abstracts and Conference Proceedings:

1. Carrell, R.C.*, **S.L. Dillard**, M.K. Mullenix, A.V. Gamble, and R.B. Muntifering. 2022. Grazing cover crops: effects of cattle removal date on forage production and cattle performance. Southern Section American Society of Animal Science. Fort Worth, TX.
2. **Dillard, S.L.**, M.K. Mullenix, S.M. Justice, M.L. Marks, M.K. Stanford, and G.L. Thompson. 2022. Transitioning the Alabama bermudagrass hay summit to a virtual workshop. Southern Section American Society of Animal Science. Fort Worth, TX.
3. Zessin, P., J.L. Jacobs, S.M. Justice, M.K. Mullenix, **S.L. Dillard**, S.P. Rodning, and D.A. Tighe. 2022. Cotton gin trash processing, quality and safety impacts on feeding recommendations for beef cattle. Southern Section American Society of Animal Science. Fort Worth, TX.

4. West, M.H.* , M.K. Mullenix, A.N. Rabinowitz, W.B. Smith, R.C. Carrell, and **S.L. Dillard**. 2022. Forage production and nutritive quality of dual-purpose wheat managed under three different grazing frequencies in the southeastern United States. Southern Section American Society of Animal Science. Fort Worth, TX.
5. South, M., **S.L. Dillard**, and D.D. Harmon. 2022. Cool-season annual forage variety selection tool for the southeastern United States. Southern Section American Society of Animal Science. Fort Worth, TX.
6. Silva, S.L.* , M.K. Mullenix, **S.L. Dillard**, and C.M. Vasco. 2022. Development of forage establishment and management educational resources for Alabama farmers. Southern Section American Society of Animal Science. Fort Worth, TX.
7. Vasco, C.M.* , S.L. Silva* , M.K. Mullenix, **S.L. Dillard**, C. Wickens, and L.K. Warren. 2022. Characterization of pasture management by horse operation purposes in Florida. Southern Section American Society of Animal Science. Fort Worth, TX.
8. Yin, J.H, **S.L. Dillard**, D.M. Rodrigues, M. Chamorro Ortega, R. Cattley. 2021. A case of Senna plant (*Cassia occidentalis*, *Cassia obtusifolia*) poisoning in a 4-month old heifer. Annual American College of Veterinary Pathologists Meeting. Virtual meeting.
9. Yin, J.H, **S.L. Dillard**, D.M. Rodrigues, M. Chamorro Ortega, R. Cattley. 2021. A case of Senna plant (*Cassia occidentalis*, *Cassia obtusifolia*) poisoning in beef cattle. Annual American College of Veterinary Pathologists Meeting. Virtual meeting.

Peer-reviewed Extension Publications:

1. Vasco, C.* , M. Justice, M. Agar, K. Mullenix, and **S.L. Dillard**. 2022. Stockpiling warm-season perennial grasses. ANR-2897.
2. Walker, M.* , C. Vasco, L.S. Silva, and **S.L. Dillard**. 2021. Decreasing the costs of feeding horses. ANR-0849.
3. Walker, M.E.* , L.S. Silva, and **S.L. Dillard**. 2021. Reading the feed tag. Alabama Cooperative Extension. ANR-1354.
4. Silva, L.S.* , M.E. Griffin, **S.L. Dillard**, and M.K. Mullenix. 2021. Measuring forage mass to adjust stocking rate. Alabama Cooperative Extension. ANR-2751.
5. **Dillard, S.L.**, A. Rabinowitz, A.V. Gamble, D. Russell, J. Sawyer, K. Kesheimer, W.K. Kelley, M.K. Mullenix, S.L. Dillard, L.S. Silva, M. Runge, R. Prasad, and S. Rodning. 2021. Alabama Forage Guide. ANR-2845. ANR-2845. *Regional NACAA Communications Award Winner*

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

Results from research related to this Hatch project were used to inform Extension meetings and Extension agent trainings such as the 2022 Pasture and Forage Extension Agent training hosted by Alabama Cooperative Extension. This meeting was attended by agents and other government agencies from 7 different states. Results were also used to inform producer meetings such as the Bermudagrass Hay Summit, experiment station field days, and county and regional-level Extension meetings.



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

A major goal of the proposed project is to understand plant-pathogen-environment interactions with the long-term goal of identifying sustainable disease management strategies.

Bacterial spot of tomato and pepper is used as a model pathosystem in the proposed project. Following objectives have been designed towards the proposed goal.

1. Understanding the bacterial spot pathogen ecology and population dynamics on tomato and pepper
2. **Understanding the pathogenicity/fitness factors of bacterial spot xanthomonads**
3. **Identification and characterization of novel sources of disease resistance in tomato and pepper against bacterial spot xanthomonads**

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

The project has studied how pathogen has changed in response to practices in agriculture and allowed to devise ecologically-derived solutions for managing the plant disease.

Obj. 1 Understanding the bacterial spot pathogen ecology and population dynamics on tomato and pepper

We sampled tomato fields in Georgia, South Carolina, North Carolina and Alabama and surveyed pathogen population. *Xanthomonas perforans* is the only species identified on tomato, although we did observe *Pseudomonas cichorii* being second most abundant species present on tomato. We performed coinfection assays to see contribution of *Pseudomonas cichorii* towards bacterial spot disease severity. However, we did not observe any increase in disease severity with *P. cichorii* coinfection with *X. perforans*. We also observed co-occurrence of multiple pathogen genotypes in tomato fields.

Obj 2. Understanding the pathogenicity/fitness factors of bacterial spot xanthomonads

We have shown that type VI secretion system of *Xanthomonas* provides epiphytic fitness and have now identified a regulator that we now hypothesize to be responsible for shift from epiphytic lifestyle to apoplastic lifestyle of the pathogen. Further we have demonstrated contribution of type VI secretion system in mediating interactions of pathogen with the resident microbiota.

Genome-wide association study that revealed role of carbohydrate metabolism and amino acid transport-associated genes in pepper specificity has now been published in *Phytopathology*. This study suggested that there are multiple steps during which genes were gained or lost that allowed pathogen to be pathogenic on pepper, first of which begins with overcoming innate immune response from the plant.

Obj 3. Identification and characterization of novel sources of disease resistance in tomato and pepper against bacterial spot xanthomonads

The two PI pepper lines that have been found to be resistant to *X. gardneri* have been used for generating crosses with susceptible parent. We have screened the F2/3s for resistance against *X. gardneri* and are in the process of analyzing genotypic data to identify markers.

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

Results were communicated with the growers during Alabama fruit and vegetable grower association meeting and with the help of Ag extension agents. Surveys have helped us identify problems and challenges of the growers in the southeast as well as learn about the current management practices growers have been implementing and seeing their effects on disease incidence. Omics in Agriculture is a new undergraduate/graduate course developed to train next-generation of students in omics data analyses. This course has been now taught for 2 semesters and students have been able to analyze their own datasets and publish their findings. We have also been conducting outreach efforts to conduct guest lectures in high schools and middle schools in Alabama to disseminate important of plant diseases in plant health and human health.

Following are peer-reviewed publications generated from the work on this project in the past year.

Dia, N. C., Morinière, L., Cottyn, B., Bernal, E., Jacobs, J. M., Koebnik, R., et al. (2022). *Xanthomonas hortorum*—beyond gardens: Current taxonomy, genomics, and virulence repertoires. *Molecular Plant Pathology* 23, 597–621.

Leisner, C. P., Potnis, N., and Sanz-Saez, A. (n.d.). Crosstalk and trade-offs: Plant responses to climate change-associated abiotic and biotic stresses. *Plant, Cell & Environment* n/a. doi: [10.1111/pce.14532](https://doi.org/10.1111/pce.14532).

Liyanapathirana, P., Jones, J. B., and Potnis, N. (2022a). Mutation of a Single Core Gene, *tssM*, of Type VI Secretion System of *Xanthomonas perforans* Influences Virulence, Epiphytic Survival, and Transmission During Pathogenesis on Tomato. *Phytopathology* 112, 752–764.

Liyanapathirana, P., Wagner, N., Avram, O., Pupko, T., and Potnis, N. (2022b). Phylogenetic Distribution and Evolution of Type VI Secretion System in the Genus *Xanthomonas*. *Frontiers in microbiology* 13, 840308–840308.

Newberry, E., Minsavage, G. V., Holland, A., Jones, J. B., and Potnis, N. (2022). Genome-Wide Association to Study the Host-Specificity Determinants of *Xanthomonas perforans*. *Phytopathology*. doi: [10.1094/PHYTO-08-22-0294-R](https://doi.org/10.1094/PHYTO-08-22-0294-R).

Osdaghi, E., Jones, J. B., Sharma, A., Goss, E. M., Abrahamian, P., Newberry, E. A., et al. (2021). A centenary for bacterial spot of tomato and pepper. *Molecular Plant Pathology* 22, 1500.

Rosenthal, E., Potnis, N., and Bull, C. T. (2022). Corrigendum: Comparative genomic analysis of the lettuce bacterial leaf spot pathogen, *Xanthomonas hortorum* pv. *vitians*, to investigate race specificity. *Frontiers in Microbiology* 13. Available at: <https://www.frontiersin.org/articles/10.3389/fmicb.2022.1044656> [Accessed January 13, 2023].

Timilsina, S., Goss, E. M., Koebnik, R., Potnis, N., and Jones, J. B. (2022). Editorial: Population and comparative genomics of plant pathogenic bacteria. *Frontiers in Microbiology* 13. Available at: <https://www.frontiersin.org/articles/10.3389/fmicb.2022.1012034> [Accessed January 13, 2023].

Wagner, N., Alburquerque, M., Ecker, N., Dotan, E., Zerah, B., Pena, M. M., et al. (2022). Natural language processing approach to model the secretion signal of type III effectors. *Front Plant Sci* 13, 1024405. doi: [10.3389/fpls.2022.1024405](https://doi.org/10.3389/fpls.2022.1024405).

Zarei, S., Taghavi, S. M., Rahimi, T., Mafakheri, H., Potnis, N., Koebnik, R., et al. (2022). Taxonomic refinement of *Xanthomonas arboricola*. *Phytopathology* 112, 1630–1639.

Non-refereed research publications (abstracts, articles, proceedings)

* indicates graduate student/postdoc mentored by Potnis.

1. Bhandari, R*, Potnis, N. Resilience of microbial community associated with phyllosphere in response to biotic and abiotic stress. Phyllosphere 2022. 11th International Symposium on Leaf Surface Microbiology, Davis, California, July 2022. (Selected for oral presentation).

2. Pena, M*, Potnis, N. Genetic and functional diversity to explain commensal, opportunistic, and pathogenic lifestyles of *Xanthomonas* spp. *Xanthomonas* Genomics Conference. June 2022. (Selected for oral presentation).

Invited Research Presentations by Potnis at Professional Meetings and Seminar Series

1. Potnis, N. Monitoring fine-scale adaptations in pathogen populations in agricultural systems. International Conference of Plant Pathogenic Bacteria. Keynote speaker. July 2022.
2. Potnis, N. Understanding the basis of host adaptation in a stealthy plant pathogenic bacterium, *Xanthomonas*. Postdoc Invited seminar speaker, Oregon State University, Department of Botany and Plant Pathology. April 2022.
3. Potnis, N. Understanding the basis of host adaptation in a stealthy plant pathogenic bacterium, *Xanthomonas*. Keynote speaker. EuroXanth COST Action 4th Annual Conference. Summer 2021.

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

The project has raised public awareness of plant diseases and plant health being important for human health. We conducted guest lectures in high schools and middle schools on plant pathogens around us. We also participated in outreach efforts that included K-12 students and their parents where we set up a table to show sick plants and what it means to be a plant doctor.

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

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

During this project period, as a part of research mentoring, six graduate students and two postdocs were trained in molecular biology techniques such as constructing deletion mutants, complementation, shotgun metagenome analyses and plant pathology techniques such as in planta population assays, disease severity ratings and pathogen isolations. Four undergraduate students were trained in basic microbiology and plant pathology techniques. Undergraduate students were also mentored for computational analyses.

How have the results been disseminated to communities of interest?

Results were communicated with the growers during Alabama fruit and vegetable grower association meeting and with the help of Ag extension agents. Surveys have helped us identify problems and challenges of the growers in the southeast as well as learn about the current management practices growers have been implementing and seeing their effects on disease incidence. Omics in Agriculture is a new undergraduate/graduate course developed to train next-generation of students in omics data analyses. This course has been now taught for 2 semesters and students have been able to analyze their own datasets and publish their findings. We have also been conducting outreach efforts to conduct guest lectures in high schools and middle schools in Alabama to disseminate important of plant diseases in plant health and human health.

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

This five-year project has provided opportunities for developing many hypotheses that will continue to be investigated in the next project currently being written. New domestic and international collaborations have been developed to explore new areas of research related to plant microbe interactions. One of the most exciting avenues that this five year project has offered is perspective on contribution of microbiome in shaping plant-pathogen interactions and our group is taking this new direction as we move forward in our goals.

Critical Issue

Global Food Security and Hunger

Developing best management practices for vegetable cropping systems in Alabama and the southeastern United States

Project Director

Andre da Silva

Organization

Auburn University



Developing best management practices for vegetable cropping systems in Alabama and the southeastern United States

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

This vegetable cropping system program at Auburn University is focused on best management practices (BMPs) for cultivar selection, irrigation strategies, fertilizer application, and other agricultural/horticultural practices for vegetable production. However, we use an inter- and multi-disciplinary approach, meaning horticultural practices are combined with integrated pest management practices to achieve our final goal of enhance the vegetable industry in southeastern U.S.

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

Research outlined in this project is targeted to increase growers' knowledge of vegetable production. Therefore, a total of 26 research and extension field trials across the state of Alabama were conducted. Field trials had the objective 1) to evaluate vegetable crops cultivars for the subtropical environmental conditions of Alabama and southeastern U.S.; 2) to develop and implement irrigation and fertilizer management practices for vegetable growing systems; 3) to develop and implement strategies against whitefly and whitefly-transmitted virus in vegetable crops; 4) to evaluate crop models for vegetable production under environmental conditions of the southeastern U.S. Because the majority of trials were applied research, science-based results could be translated to growers (goal of this project) to implement best management practices of vegetable production in their operation in the following growing season.

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

Outcomes of our research trials benefits:

Alabama farmers, the Alabama Cooperative Extension System; Alabama NRCS, Alabama Soil and Water Conservation Society, Alabama Crop Consultants, farmers in neighboring states of Georgia and Florida; members of the Alabama Fruit and Vegetable Growers Association; and the American Society of Horticulture Science.

Objective 1: to evaluate vegetable crops cultivars for the subtropical environmental conditions of Alabama and southeastern U.S.

Research trials of objective 1 were conducted for lettuce, tomato, pepper, watermelon, sweet corn, yellow squash, zucchini, acorn squash, and pumpkin. Results indicated cultivars with better performance and adaptability to the environmental conditions of Alabama

Objective 2: to develop and implement irrigation and fertilizer management practices for vegetable growing systems.

Research trials of objective 2 evaluated different irrigation scheduling for watermelon and tomato production. Anticipated outcomes indicated that growers can reduce water usage during irrigation events by 60% and 40% in watermelon and tomato production with the use of soil moisture sensors to compared to the current growers' practices of applying the same volume of water every day, also known as systematic irrigation. Irrigation water reduction did not impact crop yields and values represented a water saving of 300,000 gallons/acre for watermelon production and 182,000 gallons/acre for tomato production during the entire growing season. In addition, research trials of objective 2 evaluated different fertilizer nitrogen rates for sweet corn production, and anticipate results indicate growers can reduce fertilizer nitrogen rates by up to 100 lb/acre to their current practice of 300 lb of nitrogen/acre without impacting yield.

Objective 3) to develop and implement strategies against whitefly and whitefly-transmitted virus in vegetable crops.

Research trials of objective 2 evaluated different crop management practices and insecticides to manage whiteflies in southeast Alabama. Results indicated the silver plastic mulching and row cover reduce the whitefly population compared to the current use of white plastic and no cover. Similarly, specific insecticides better controlled the pest population compared to others.

To achieve our goal of providing growers with science-based information. Results from our trials were first shared with the science community through the publication of peer-review manuscript. Later, results were published as extension bulletins, where science-based information was translated to general public.

Below is the list of peer-review research publications in 2022 (total = 9):

- **da Silva, A.L.B.R.**, C. Rodrigues, L. Dunn, G. Cavender, T. Coolong. 2022. Fertilizer nitrogen application for short-day onion production: from field to table. *Horticulturae*, 8, 847. <https://doi.org/10.3390/horticulturae8090847>
- de Lima Filho, R.B., Resende, J.T.V., de Oliveira, J.R.F., Nardi, C., Silva, P.R., Rech, C., Oliveira, L.V.B., Ventura, M.U., **A.L.B.R. da Silva**. 2022. Relationship between acylsugars and leaf trichomes: mediators of pest resistance in tomato. *Insects*, 13, 738. <https://doi.org/10.3390/insects13080738>
- **da Silva, A. L.B. R.**, M.F.L. de Barros, W. Foshee, J.S. Candian, J.C. Diaz-Perez. 2022. Priming strategies for parsley seedling production. *HortScience*, 57, 1086-1091.
- Barth, E., J.T.V. de Resende, K.H. Marigulele, M.D.V. de Resende, **A.L.B.R. da Silva**, S. Ru. 2022. Multivariate analysis methods improve the selection of strawberry genotypes with low cold requirement. *Scientific Reports*, 12, 11458 <https://doi.org/10.1038/s41598-022-15688-4>
- LaTora, A.G., C.B. Codod, S. Legarrea, B. Dutta, B., R.C. Kemerait, S. Adkins, W. Turechek, T. Coolong, **A.L.B.R. da Silva**, R. Srinivasan. 2022. combining cultural tactics and insecticides for the management of the sweetpotato whitefly, *Bemisia tabaci* MEAM1, and viruses in yellow squash. *Horticulturae*, 8, 341.
- Coolong, T., K. Cassity-Duffey, **A.L.B.R. da Silva**. 2022. Influence of nitrogen rate, fertilizer type, and application method on cabbage yield and nutrient concentrations. *HortTechnology*, 32: 134-139 (<https://doi.org/10.21273/HORTTECH04982-21>).
- Luckew, A., G. Meru, Y. Wang, R. Mwatuwa, M. Paret, R. Carvalho, M. Kalischuk, **A.L.B.R. da Silva**, J. Candian, B. Dutta, R. Srinivasan, S.R. Kavalappara, S. Beg, C. McGregor. 2022. Field evaluation of cucurbita germplasm for resistance to whiteflies and whitefly-transmitted viruses. *HortScience*, 57: 337-344 (<https://doi.org/10.21273/HORTSCI16197-21>)
- Karki, K., J. Grant, **A.L.B.R. da Silva**, A. Petkar, A. Hajihassani, T. Coolong, B. Dutta. 2022. Evaluation of Pic-clor 60 [chloropicrin pre-mixed with 1,3 dichloropropene] and soil-applied fungicides for the Fusarium wilt management in watermelon. *Journal of Crop Protection*. <https://doi.org/10.1016/j.cropro.2021.105894>.
- Rens, L.R., L. Zotarelli, **A.L.B.R. da Silva**, C.J.B. Ferreira, C.A. Tormena, D.L. Rowland, K.T. Morgan. 2022. Managing water table depth thresholds for potato subirrigation. *Agricultural Water Management* (<https://doi.org/10.1016/j.agwat.2021.107236>).

Below is the list of peer-review extension publications in 2022 (total = 6):

- Majumdar, A., M. Gothard, **A.L.B.R. da Silva**, B. Carter, A. Stokes, H. Willis, A. Chambliss, D. Carroll, E. Schevey, C. East, N. Kelly. 2022. Home and Market Garden (Urban Farm) IPM Toolkit. Alabama Cooperative Extension System. Extension Bulletin ANR-2397.

- **da Silva, A.L.B.R.**, S. Oliveira, Z. Jones, S. Li. 2022. Growing organic vegetables in Alabama: Know your weeds. Alabama Cooperative Extension System. Alabama Cooperative Extension System. Extension Bulletin ANR-2923.
- **da Silva, A.L.B.R.** 2022. Vegetable seedlings production. Alabama Cooperative Extension System. Extension Bulletin ANR-2899.
- Majumdar, A., **A.L.B.R. da Silva**. 2022. Organic vegetable IPM toolkit. Alabama Cooperative Extension System. Extension Bulletin ANR-2190.
- Kemble, J., **A.L.B.R. da Silva**, et al. 2022. Southern region vegetable handbook 2022.
- Zotarelli, L., C.E. Barret, **A.L.B.R. da Silva**, C.T. Christensen, G.K. England. 2022. Nitrogen fertilization guidelines for bare-ground and plastic mulch cabbage production in Florida. University of Florida IFAS Extension, EDIS Publication – HS1428.

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

Benefits of this program to our direct clients (vegetable growers and industry) come through presentations and workshops (listed below), in which information on best management practices can be readily incorporated in vegetable production areas increasing growers' yield and revenue. The indirect clients (community) of this program benefit from results because of the enhancement of vegetable production and increase of produce/fruit quality allows for a more nutritional and health food availability.

Below is the list of presentations in field days, vegetable meetings, and workshops conducted in 2022:

Presentations (total = 10):

- **da Silva, A.L.B.R.** 2022. Vegetable cultivar selection for high tunnel systems. High tunnel Crop Production and Pest Management Field Day in Dale County, Alabama (10 attendees).
- **da Silva, A.L.B.R.**, J. Kelley. 2022. Best management practices for vegetable production in Alabama. In Poarch Creek Field Day / Commercial Horticulture Team – Alabama Cooperative Extension System (9 attendees).
- **da Silva, A.L.B.R.** 2022. Management of whitefly and cultivar selection for vegetable fall season. Henry County meeting / Commercial Horticulture Team – Alabama Cooperative Extension System (10 attendees).
- **da Silva, A.L.B.R.** 2022. Vegetable high tunnel irrigation and fertilizer management. Hale County meeting / Commercial Horticulture Team – Alabama Cooperative Extension System (14 attendees).
- **da Silva, A.L.B.R.** 2022. High tunnel vegetable production update to northeast Alabama. Dekalb County meeting / Commercial Horticulture Team – Alabama Cooperative Extension System (10 attendees).
- **da Silva, A.L.B.R.** 2022. Vegetable high tunnel production. Autauga and Elmore Counties meeting / Commercial Horticulture Team – Alabama Cooperative Extension System (26 attendees).
- **da Silva, A.L.B.R.** and N. Kelly. 2022. Identifying challenges of vegetable production in southeastern Alabama. Dale County meeting / Commercial Horticulture Team – Alabama Cooperative Extension System (8 attendees).

- **da Silva, A.L.B.R.** 2022. Making the most of your field: Succession planting and crop rotation. Talladega County meeting / Commercial Horticulture Team – Alabama Cooperative Extension System (10 attendees).

- **da Silva, A.L.B.R.** and C. Rodrigues, 2022. Water management for vegetable crops in Alabama. Tallapoosa County meeting / Commercial Horticulture Team – Alabama Cooperative Extension System (17 attendees).

- **da Silva, A.L.B.R.** 2022. Alabama Vegetable Crops. All ACES meeting – Alabama Cooperative Extension System.

Workshops and field days (total = 14):

- **da Silva, A.L.B.R.**, A. Sanz-Saez (2022). Installing and managing a hop yard. In Auburn University Oktoberfest organized by Ithaka Hospitality Partners.
- **da Silva, A.L.B.R.** (2022). Making the most of your garden: Crop Rotation and cultivar selection. In Master Gardeners Seminar / Home Grounds Team – Alabama Cooperative Extension System.
- **da Silva, A.L.B.R.** (2022). Pumpkins management during the fall season. In Chilton Fruit and Vegetable Field Day / Commercial Horticulture Team – Alabama Cooperative Extension System.
- **da Silva, A.L.B.R.**, D. Lawrence (2022). Fertilizer management and variety selection for tomato production. In Advanced Tomato Workshop / Home Grounds Team – Alabama Cooperative Extension System.
- **da Silva, A.L.B.R.** (2022). Growing tomato for beginners. In Tomato Workshop / Home Grounds Team – Alabama Cooperative Extension System.
- **da Silva, A.L.B.R.** (2022). Alabama Vegetable Crops Field Day. In Vegetable School Program from the Commercial Horticulture Team – Alabama Cooperative Extension System.
- **da Silva, A.L.B.R.** (2022). Cucurbits crop management and variety selection. In Vegetable School Program from the Commercial Horticulture Team – Alabama Cooperative Extension System.
- **da Silva, A.L.B.R.** (2022). Tomato crop management and variety selection. In Vegetable School Program from the Commercial Horticulture Team – Alabama Cooperative Extension System.
- **da Silva, A.L.B.R.** (2022). Use of high tunnels for vegetable production. In Vegetable School Program from the Commercial Horticulture Team – Alabama Cooperative Extension System.
- **da Silva, A.L.B.R.** (2022). Strawberry irrigation overview. In Strawberry School for New Growers and Extension Agents. Auburn, AL., USA.
- **da Silva, A.L.B.R.**, (2022). Irrigation management for vegetable crops in Alabama. In Vegetable School Program from the Commercial Horticulture Team – Alabama Cooperative Extension System.

- **da Silva, A.L.B.R.**, (2022). Scheduling irrigation events for vegetable crops. Mitchel County / University of Georgia Extension – Irrigation update meeting. Camila, GA, USA.
- **da Silva, A.L.B.R.**, (2022). Introduction to Alabama vegetable crops program. Alabama Cooperative Extension System – ALL ACES January monthly meeting.
- **da Silva, A.L.B.R.**, (2021). Soil moisture sensor for improving vegetable production. Alabama Cooperative Extension System – Commercial Horticulture Team Webinar Series.

Improving Skills of Alabama Agricultural Producers through Economic Education and Leadership in Production, Marketing, Financial, Policy, and Human Risk Management

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7004562

★ Improving Skills of Alabama Agricultural Producers through Economic Education and Leadership in Production, Marketing, Financial, Policy, and Human Risk Management - Annual

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

There are over 40,000 farms in Alabama situated over 8 million acres of land. These producers annually produce a market value of roughly \$6 billion across the livestock, poultry, row crop, and specialty crop sectors. The Alabama Cooperative Extension System Farm and Agribusiness Management Team provides economic education and leadership in five key areas of risk management in agriculture. During times of volatility in market prices, input costs, and regulations, uncertainty makes development of risk management skills essential to maintain profitability and enhance economic growth.

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 Farm and Agribusiness Management Team uses multiple means of communication to reach its audience throughout Alabama. Face-to-face outlook and marketing meetings took place in various counties throughout the state at different times of the year to maximize reach. Issues of marketing, production, and policy risk are of primary focus at these meetings. New in 2022 was a farm financial management workshop series that provided a foundation focused on financial risk management skills. The human risk aspect was addressed through a series of agricultural labor workshops, with particular emphasis on the H-2A guestworker program. Digital and print media are also a primary outlet for risk management education. The team maintains over 40 enterprise budgets spanning livestock, forages, row crops, and horticulture production. Two newsletters, Profit Profiles and Ag Economic Update, provide regular updates on market conditions and policy issues in farm management. Additional publications occur through the Alabama Cooperative Extension System website, and various trade magazines including the Alabama Cattleman magazine and Cooperative Farming News. Members of the team are also regular contributors to Southern Ag Today, a collaboration of the 13 land grant institutions in the U.S. south. In 2022, a New Farmer's Guide to the Commercial Broiler Industry was published as a five-part series designed to help farmers navigate the complexities of entering the commercial broiler industry. All of these outlets provide for greater reach and distribution of risk management education and help provide leadership to agricultural producers in Alabama.

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

Participants in our program increased their knowledge of strategies to manage risk given current agricultural-market and farm-economic conditions. The knowledge is also used to develop future expectations and farm management decisions to increase profitability and create new economic opportunities. The average knowledge gain increased over one position on a 5-point Likert scale that spanned from not knowledgeable to extremely knowledgeable. A total of 90% of participants

indicated an intent to use the information provided while 93% said they would recommend the program to others. The programming also greatly exceeded expectations, with 76% reporting it was better than expected, showing growth in the team's educational offerings.

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

The broader public benefited by increasing their understanding of Alabama agriculture and how agricultural risk management skills help producers maintain profitability and enhance economic growth. With application of this education, there is also a broader impact to the general public through the generation of additional economic activity in local communities.

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.

Number of Publications: Extension - 39 Research - 0 Total (calculated) - 39

Sustainable Solutions to Problems Affecting Bee Health

Project Director
Geoffrey Williams
Organization
Auburn University
Accession Number
1025650



Sustainable Solutions to Problems Affecting Bee Health in the Southeast United States

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

High losses of honey bee colonies are observed annually in the United States. The work of this project addresses this issue by identifying important biotic and abiotic stressors of honey bee colonies, then developing practical best management practices for beekeepers and land managers to deploy to mitigate these losses.

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

Work towards addressing the problem of high annual honey bee colony losses can be allocated to two project objectives. The purpose of the first objective is to better understand the contribution of key biotic and abiotic factors to honey bee colony health. Overall, we demonstrated the importance of the parasitic mite *Varroa destructor*, even alongside other stressors such as agricultural chemicals and weather. Both laboratory and field studies confirmed this. Furthermore, we demonstrated the importance of weather to honey bee colony loss. For example, we identified that extreme weather and precipitation events are among the most important drivers. The purpose of the project's second objective is to develop best management practices for beekeepers and land managers to promote the health of honey bee colonies. For this, we communicated results of our national study on the effects of weather to beekeepers with the intent to better prepare them for future extreme weather events. Furthermore, we performed multiple varroa management trials using cultural prevention techniques and chemical controls to identify effective best management practices.

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

Beekeepers were the primary beneficiaries to our work, especially concerning the project's goal to develop and recommend best management practices to promote colony health. This past year we published the results of one study concerning oxalic acid, and we performed a study that sought to determine optimal control treatments during honey bee colony splitting using queen cells, a very common method by beekeepers to increase their colony numbers. Results from this work, as well as work performed during the previous year, were communicated to beekeepers via a number of channels. For example, we attended meetings of the Alabama Beekeepers' Association, the Indiana Beekeepers' Association, and the American Honey Producers' Association. Furthermore, we communicated information via Alabama Extension's Beekeeping Newsletter, and coordinated a regional webinar called At Home Beekeeping. Ultimately, we believe this knowledge transfer has informed beekeepers of new pest management options that are suitable for adoption.

Journal Articles

- Bruckner, S., Wilson, M., Aurell, D., Rennich, K., vanEngelsdorp, D., Steinhauer, N., **Williams, G.R.** 2023. A national survey of managed honey bee colony losses in the USA: results from the Bee Informed Partnership for 2017–18, 2018–19, and 2019–20, Journal of Apicultural Research <https://doi.org/10.1080/00218839.2022.2158586>
- Bruckner, S., Straub, L., Neumann, P., **Williams, G.R.** 2023. Negative but antagonistic effects of neonicotinoid insecticides and ectoparasitic mites *Varroa destructor* on *Apis mellifera* honey bee food glands. Chemosphere 313, 137535. <https://doi.org/10.1016/j.chemosphere.2022.137535>
- Insolia, L., Molinari, R., Rogers, S.R., **Williams, G.R.**, Chiaromonte, F., Calovi, M., 2022. Honey bee colony loss linked to parasites, pesticides and extreme weather across the United States. Scientific Reports 12, 20787. <https://doi.org/10.1038/s41598-022-24946-4>
- Overturf, K.A., Steinhauer, N., Molinari, R., Wilson, M.E., Watt, A.C., Cross, R.M., vanEngelsdorp, D., **Williams, G.R.**, Rogers, S.R. 2022. Winter weather predicts honey bee colony loss at the national scale. Ecological Indicators 145, 109709. <https://doi.org/10.1016/j.ecolind.2022.109709>
- Papach, A., Beaufort, A., Yañez, O., Huwiler, M., **Williams, G.R.**, Neumann, P. 2022. Multiple mating by both sexes in an invasive insect species, *Aethina tumida* (Coleoptera: Nitidulidae). Insect Science <https://doi.org/10.1111/1744-7917.13112>
- Straub, L., Strobl, V., Bruckner, S., Camenzind, D.W., Van Oystaeyen, A., Wäckers, F., **Williams, G.R.**, Neumann, P. 2022. Buffered fitness components: Antagonism between malnutrition and an insecticide in bumble bees. Science of The Total Environment 833, 155098. <https://doi.org/10.1016/j.scitotenv.2022.155098>
- Papach, A., Balusu, R., **Williams, G.R.**, Fadamiro, H.Y., Neumann, P. 2022. The smell of sex: cuticular hydrocarbons of adult small hive beetles, *Aethina tumida* (Coleoptera: Nitidulidae). Journal of Apicultural Research 61, 365-367. <https://doi.org/10.1080/00218839.2021.2015057>
- Berry, J., Bartlett, L.J., Bruckner, S., Baker, C., Braman, K., Delaplane, K.S., **Williams, G.R.** 2022. Assessing repeated oxalic acid vaporization in honey bee (*Apis mellifera*) colonies for control of the ectoparasitic mite *Varroa destructor*. Journal of Insect Science 22, <https://doi.org/10.1093/jisesa/ieab089>.
- Bartlett, L.J., Bruckner, S., Delaney, D.A., **Williams, G.R.**, Delaplane, K.S., 2022. A computational approach to tracking age-based task frequency distributions of *Apis mellifera* worker cohorts. Journal of Apicultural Research, 61, 147-150. <https://doi.org/10.1080/00218839.2021.1909313>

Conference Presentations

- Aurell, D., Bartlett, L., Berry, J., Bruckner, S., Cook, S., Rinkevich, F., **Williams, G.** Advances in varroa research. American Honey Producers, Tucson, AZ, USA, in person, 2 December 2022. **Participants: 100**
- Aurell, D., Wall, C., Bruckner, S., **Williams, G.** Combining amitraz and thymol to manage Varroa mites in honey bee colonies. Entomological Society of America 2022, Vancouver, BC, Canada, in person, 14 November 2022. **Participants: 55**
- Aurell, D., Bartlett, L., Berry, J., Bruckner, S., Cook, S., Rinkevich, F., **Williams, G.** Advances in varroa research: from social to natural sciences. Maryland State Beekeepers' Association, Annapolis, MD, USA, in person, 12 November 2022. **Participants: 100**
- Bruckner, S. Beekeeper learning. Alabama Beekeepers Association Annual Convention, Clanton, AL, USA, in person, 16 September 2022. **Participants: 20**
- Aurell, D. Varroa Mite Management in Spring Splits Alabama Beekeepers Association Annual Convention, Clanton, AL, USA, in person, 16 September 2022. **Participants: 50**
- **Williams, G.**, Steinhauer, N., Aurell, D., Bruckner, S., Wilson, M., Rennich, K., vanEngelsdorp, D. Best Management Practices - The varroa mite. East Tennessee Beekeepers, Athens, TN, USA, in person, 27 August 2022. **Participants: 100**
- **Williams, G.**, Steinhauer, N., Aurell, D., Bruckner, S., Wilson, M., Rennich, K., vanEngelsdorp, D. BMPs from BIP. East Tennessee Beekeepers, Athens, TN, USA, in person, 27 August 2022. **Participants: 100**
- Bruckner, S. Pathogens, Viruses and Disease. Alabama Beekeepers Association Master Beekeepers, Clanton AL, USA, in person, 29 July 2022. **Participants: 15**
- Aurell, D., Bartlett, L., Berry, J., Bruckner, S., Cook, S., **Williams, G.** Evaluating the efficacy of Aluen CAP against Varroa mites in honey bee colonies. Madison Co. Beekeepers, Huntsville, AL, USA, in person, 12 May 2022. **Participants: 16**
- Aurell, D., Bartlett, L., Berry, J., Bruckner, S., Cook, S., **Williams, G.** Aluen CAP Miticide Study. Bee Informed Partnership - Colloquium, online, 29 April 2022. **Participants: 20**
- Aurell, D., Wall, C., Bruckner, S., **Williams, G.** Combining amitraz and thymol. Bee Informed Partnership - Colloquium, online, 29 April 2022. **Participants: 20**
- **Williams, G.**, Steinhauer, N., Aurell, D., Bruckner, S., Wilson, M., Rennich, K., vanEngelsdorp, D. Best Management Practices: The Varroa Mite. Southwest Georgia Beekeepers' Association, Albany, GA, USA, in person, 14 April 2022. **Participants: 50**
- Straub, L., Villamar-Bouza, L., Bruckner, S., Chantawannakul, P., Kolari, E., Maitip, J., Vidondo, B., Neumann, P., **Williams, G.** Diverse effects of neonicotinoids on male honey bees. Entomological Society of America - Southeast Branch Annual Meeting, San Juan, Puerto Rico, in person, 26-30 March 2022. **Participants: 50**

- **Williams, G.**, Steinhauer, N., Aurell, D., Bruckner, S., Kulhanek, K., Rennich, K., vanEngelsdorp, D. Keep your bees alive by listening to the Bee Informed Partnership. The Beekeepers of Indiana - Bee School XX; Muncie, IN, USA, in person, 26 February 2022. **Participants: 100**
- **Williams, G.**, Steinhauer, N., Aurell, D., Bruckner, S., Wilson, M., Rennich, K., vanEngelsdorp, D. Best Management Practices: The Varroa Mite. The Beekeepers of Indiana - Bee School XX; Muncie, IN, USA, in person, 26 February 2022. **Participants: 100**
- Aurell, D., Bartlett, L., Berry, J., Bruckner, S., Cook, S., **Williams, G.** Evaluating the efficacy of Aluen CAP against Varroa mites in honey bee colonies. ALFA Commodities Meeting, Auburn University, AL, USA, in person, 10 February 2022. **Participants: 15**
- **Williams, G.**, Steinhauer, N., Aurell, D., Bruckner, S., Kulhanek, K., Rennich, K., vanEngelsdorp, D. Keep your bees alive by listening to the Bee Informed Partnership. ACES Beekeeping Symposium, online, 5 February 2022. **Participants: 70**
- Aurell, D., Bruckner, S., **Williams, G.** Sneak preview: An upcoming experiment on Varroa mite management in spring splits. ACES Beekeeping Symposium, online, 5 February 2022. **Participants: 60**
- Aurell, D., Bartlett, L., Berry, J., Bruckner, S., Cook, S., **Williams, G.** Evaluating the efficacy of Aluen CAP against Varroa mites in honey bee colonies. American Bee Research Conference 2022, online, 14 January 2022. **Participants: 115**

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

Honey bees are vital pollinators of many agricultural crops, especially specialty crops like almonds, blueberries, and cucurbits. Because much of our work was performed in consultation with commercial beekeepers that deliver this pollination service, our work translates to public consumers of fruits and vegetables grown in the United States by helping improve productivity of honey bee colonies.

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

There were no major changes or problems encountered during the past year. All of our experiments included training opportunities for undergraduate and graduate students, as well as a post-doc. For all groups, this included honey bee colony management, honey bee colony assessment, and scientific data collection techniques. For graduate students and the post-doc, this included data analysis, reporting, and communication. The graduate student also took multiple graduate level courses concerning entomology and statistics. Furthermore, our graduate student and post doc participated in multiple conferences and stakeholder events, including the Entomological Society of America, American Bee Research Conference, and American Beekeeping Federation Conference.

[Improving Peach Production and Marketing in Alabama](#)

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7002302



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

Global climate change has had a significant impact on the peach industry affecting the number of chill hours necessary for dormancy break, late season frosts, increased occurrence of soil-borne and foliar diseases, and economically important insect pests. These factors have not only affected production but have also created challenges for marketing of the crop.

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 project addresses two major threats to the peach industry: economically important soil pathogens (ex. Armillaria root rot) and effects of climate change. The most sustainable means to address these issues is through breeding. The results of which are often in the distant future. However, peach growers can benefit from this research because it looks to bring practical, researchbased solutions to these challenges in a more immediate fashion.

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

The peach industry is a leading industry and the most economically important fruit crop industry in the state. Retail businesses such as Peach Park and Durban Farms, which are local entertainment mainstays and popular tourist destinations located off Interstate 65 are major generators of revenue and creators of jobs. In addition, other businesses in the area benefit from the spill over generated from increased foot traffic. The broader public, therefore, benefits from the generation of revenue and creation of jobs.

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

Major activities were 1) Evaluation of dormancy breaking substances 2) Effects of Armillaria root rot mitigation strategies on the growth and development of peach 3) Use of colored plastic mulches to increase plant growth and availability of Armillaria root rot resistant rootstock and d) Peach variety evaluation. These activities were useful in both determining the feasibility of the actual use of these solutions to common production challenges in Alabama (experimentation) and the dissemination of our findings at conferences, workshops, webinars, research farm tours, and professional development opportunities for Extension personnel.

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

No major changes have been encountered. Training for Extension personnel was made available during an experiment station tour dedicated to training and professional development of both new and seasoned Extension personnel. In addition, further training opportunities were provided during monthly Commercial Horticulture Team webinars and fruit and vegetable conferences. Information has been disseminated to communities of interest through research farm tours, webinars and other virtual programming.

Number of Publications: Extension - 3 Research - 2 Total (calculated) - 5

Sustainable Livestock Systems

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7002290



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

The objective of the Sustainable Livestock Production Systems Program Plan of Work is to provide a comprehensive set of programming efforts for livestock producers (beef, dairy and equine) to teach best management practices to enhance on-farm sustainability.

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

A comprehensive set of programming efforts were developed and delivered to forage-livestock producers. This included: production meetings, meeting series, on-farm (AAES Outlying Research Units and private farms) demonstrations, field days and hands-on learning meetings, web-based educational content (Beef and Forage Basics Online Courses, publications, videos, popular press articles, social media, Animal Science and Forage Team Quartely E-Update). There were 96 livestock production meetings delivered in the state in 2022 with 3,340 contacts reported. One highlighted meeting was the Gulf Coast Cattlemen's Conference, which was started in 2022 as an annual program focused on best management practices for beef producers in South Alabama. There were 167 attendees at the meeting which impacted 36,583 acres and 12,852 head of cattle. A post-program survey noted that 98% of attendees planned to implement one or more management practices discussed in the next 12 months. The Beef Systems Short Course is a multi-night meeting series for new and beginning cattle producers. Four short courses were offered across the state in fall 2022. There were 69 attendees with 44% of participants reporting this was their first time to attend an Extension meeting. The opportunity to learn and gain expertise in retained ownership to receive full carcass, feed yard, and post-weaning health performance was offered resulting in 26 total operations participating with 675 calves in the 2021-2022 program year and 250 calves in the current 2022-2023 program year through the Alabama Pasture to Rail Program. The 2021-2022 Alabama Pasture to Rail Program had an economic impact of \$775,158 with a range in average profit per head of \$27.38 to \$214.70, and participants gained in depth knowledge in the economics of retained ownership, received full carcass, feed yard, and post-weaning health performance.

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

The target audience for the Sustainable Livestock Systems program consists of both internal and external stakeholders. Internal stakeholders include regional Extension agents, county Extension coordinators, Animal Science and Forage Graduate Students, and faculty/student collaborators in the College of Agriculture and College of Veterinary Medicine at Auburn University. External stakeholders include new and/or beginning beef cattle producers or land owners, stocker cattle operators, cow-calf producers, forage growers, federal agencies, commodity groups, and industry partners.

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

Educational initiatives for the Sustainable Livestock Systems program 1) enhance land conservation for agricultural use in Alabama, 2) ensure a safe and secure food supply chain, and 3) promote animal care and well being.

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.

Based on post-program surveys and direct feedback from clientele, the program plans to emphasis hands-on educational opportunities and demonstrations for forage-livestock producers in the next year. Supporting educational materials will be developed or revised to distribute along with these resources. Continuing to build scholarly content for the ACES website on livestock and forages is a priority for agents to have as a quick reference resource to address responsive programming.

Small Ruminant Program- Advantages of Using Forestland for Meat Goat Production

Project Director
Kimberly Holmes
Organization

**Small Ruminant Program- Advantages of Using Forestland for Meat Goat Production (ANNUAL)**

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

The current demand for goat meat in the U.S. surpasses the domestic supply. In parallel, producers are also facing challenges to successful herd management, such as invasions of dewormer-resistant parasites, unexpected increases in feed costs, and limited knowledge of optimal animal production techniques. This program provides training that increases awareness of agroforestry's economic, social, and environmental benefits to farmers and forest landowners on small and medium-sized farms. The program increases the education of stakeholders about factors that lead to successful meat-goat enterprises. The target audience is goat and sheep producers and forestland owners.

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.

Technical assistance visits (65) and on-site demonstration workshops (four) were held, webinars were offered and publications were issued for landowners and small ruminant producers to educate audiences regarding the biological and economic benefits of integrating goat production with forestland management. Indirect contacts through content posted on social media reached 32,254 persons. The program materials posted on the Extension website also reached 19,325 persons.

The program team led a monthly virtual Small Ruminant Webinar series, in addition to in-person workshops, and lectures for undergraduate students. A total of 327 participants registered for virtual sessions and 194 attended. The Small Ruminant Newsletter reached 191 persons. Also, Extension articles and 7 peer-reviewed articles were published on small ruminant production and management.

The Livestock Youth Connect program, which aims to boost the number of undergraduate students who pursue careers in Animal Science, provided 4 minority students in the AAMU College of Agricultural, Life and Natural Sciences a 5-month internship on advanced livestock production techniques. Students were also inspired to become Cooperative Extension professionals.

The 2022 Goat and Sheep Summit was held on September 17, 2022, at the AAMU Agricultural Research Farm. There were 104 participants, including adults and youth. Summit activities included interactive presentations and on-site demonstrations from goat and sheep experts and USDA Program Officers. A mobile lab with STEM experiments and hayrides were implemented for youth.

Summit evaluation results:

- 80% of participants indicated a willingness to implement lessons learned on their farms.
- 100% of participants indicated high satisfaction with the Summit overall.

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

Respondents to a post-training assessment reported the following (n=100):

- Learned new techniques for managing parasites (92%)
- Learned methods for reducing input costs (medicine and grain) (78%)
- Planned to develop a new or upgrade an existing biosecurity and disease control plan (73%)

- o Successfully increased foraging operations while reducing dependency on grain supplements. (5%)

The techniques learned specifically help underserved and nontraditional audiences to improve overall farm productivity by reducing farm losses related to diseases and animal drug costs. The implementation also contributed to a reduction in the socio-economic inequality among communities by empowering underserved and limited resource farmers to apply for different grant opportunities.

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

Results of the demonstration study indicated that goats reduced understory plant cover and invasive weed species in grazed pastures by 50%. This has a positive impact on the environment and communities who live in or near these areas. Moreover, increases in farm revenue and increases in available food supplies that result from goat grazing have a positive impact on broader communities that are strengthened in terms of food security and economic viability.

Closing Out (end date 03/06/2024)

Development of technologies and best management practices to reduce environmental footprints of nitrogen and phosphorus emanating from animal agriculture in Alabama

Project Director

Rishi Prasad

Organization

Auburn University

Accession Number

1018886

★ Development of technologies and best management practices to reduce environmental footprints of nitrogen and phosphorus emanating from animal agriculture in Alabama

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

Alabama ranks third among U.S. states in broiler production. The poultry industry generates manure aka poultry litter (PL), which is a source of nutrients (such as nitrogen (N), phosphorus (P), potassium (K) etc.) for pasture and row crops. Farmers typically apply PL based on N needs of crops. Since the P needs of crops is 3-4 folds less than N, seasonal application of manure year after year leads to the build of P in soil over time. The project addresses the sustainable use of PL. The goal of the project is to minimize environmental problems arising from repeated applications of animal waste on agricultural lands.

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

The activities in 2022 were focused on understanding the P pools of manure-impacted soil using hedley P fractionation method. Soil samples were collected from Alabama farmlands from four depths: 0-5 cm, 5-15 cm, 15-30 cm, and 30-45 cm. The samples were categorized into six Alabama STP ratings namely extremely high (EH), very high (VH), high (H), medium (M), low (L), and very low (VL) based on STP concentrations. The results from this study indicated that P fractions were highly stratified across depths in all five soil regions. The water-P and calcium-magnesium-associated P pools were found to be the least dominant P pools. Iron-aluminum P and recalcitrant P were the most dominant P pools in non-calcareous soil regions. In the case of calcareous soils calcium-magnesium-associated P and recalcitrant P were found to be the two dominant pools in the whole soil profile. In addition, with the transition of P fertility rating from VL to EH, the proportion of recalcitrant P pool decreased significantly with the corresponding increase in labile P fractions. Greater amounts of P in labile and moderately labile P pool in EH, VH, and H soils pose environmental concerns. The study indicated that best management practices should be targeted to manage EH, VH, and H soils. A second study focused on predicting the P sorption-desorption parameters using selected soil variables or soil test indicators. A strong relationship between P sorption-desorption parameters and PSROx was observed and indicated that PSROx could be effectively used to predict P sorption-desorption parameters for the Piedmont soils without performing time-consuming batch isotherm experiments. Both these works will significantly help make smart decisions on using PL sustainably on agricultural lands.

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

My target audiences in the project are soil scientists, policymakers, Extension specialists, and farmers. My lab group and I presented the research information at conferences, Extension meetings, invited presentations at Farmer's meetings, peer review manuscripts, and Extension publications. Below is a list of manuscripts, thesis, extension publications, and talks at conferences that benefited diverse clientele.

Thesis

1. Kaur., G. 2022. The Distribution of Phosphorus Pools in Alabama Soil Regions and their Variation with Soil Depth. Masters's thesis, Auburn University.

Manuscripts

1. Chakraborty, D., **R. Prasad**, D. B. Watts, H. A. Torbert. 2022. Exploring alternate methods for predicting sorption-desorption parameters for environmental phosphorus loss assessment in poultry litter-impacted soils. Journal of Environmental Management 317: 115454
2. Gulizia, J.P., M.S. Rueda, F.K. Ovi, S.M. Bonilla, **R. Prasad**, M.E. Jackson, O. Gutierrez, W.J. Pacheco. 2022. Evaluate the effect of a commercial heat-stable phytase on broiler performance, tibia ash, and mineral excretion from 1 to 49 days of age assessed using nutrient-reduced diets. Journal of Applied Poultry Research 100276.

Extension Articles

1. **Prasad, R.** (50%), and D. Chakraborty. 2022. Phosphorus Basics: Testing soil phosphorus for agronomic and environmental purposes. [ANR-2866](#). Apr 2022. The Alabama Cooperative Extension System.

Conference presentation

1. *Singh, R., **R. Prasad**, D.B. Watts, and H.A. Torbert. 2021. Identification of optimum side dress nitrogen rate for dryland corn using poultry litter as starter fertilizer. Poster Presentation. 2021 ASA, CSSA, SSSA International Annual Meeting. Salt Lake City, UT. Nov 7-10, 2021.
2. **Prasad, R.**, and D. Chakraborty. 2021. Stratification of phosphorus forms and its environmental implication in soils impacted with poultry litter. Poster Presentation. ASA-CSSA-SSSA International Annual Meeting. Salt Lake City, UT. Nov 7-10, 2021.
3. Chakraborty, D. and **R. Prasad**. 2021. Phosphorus retention and release from soils receiving repeated poultry litter applications. Poster Presentation. ASA-CSSA-SSSA International Annual Meeting. Salt Lake City, UT. Nov 7-10, 2021.
4. Chakraborty, D. and **R. Prasad**. 2021. Extraction efficiency of inorganic and organic extractants to solubilize phosphorus from poultry litter. Poster Presentation. ASA-CSSA-SSSA International Annual Meeting. Salt Lake City, UT. Nov 7-10, 2021.
5. *Kaur, G., D. Chakraborty, **R. Prasad**. 2021. Characterization of phosphorus pools in Alabama soil regions. Poster Presentation. Auburn University-College of Agriculture Graduate Student Research Poster Showcase. Auburn, AL. Oct 28, 2021.
6. *Kaur, G., D. Chakraborty, **R. Prasad**. 2021. Evaluating the changes in phosphorus pools with soil depth in five Alabama soil regions. Poster Presentation. ASA-CSSA-SSSA International Annual Meeting. Virtual Meeting. Nov7-10, 2021.
7. *Powell, A., **R. Prasad**, D. Watts, D. Chakraborty, A. Torbert. 2021. Effects of gypsum-amended poultry litter on nutrient release and runoff. Poster Presentation. Auburn University College of Agriculture Research Showcase. Auburn, AL. Oct 28, 2021. (*Awarded best poster*).

8. *Powell, A., **R. Prasad**, D. Watts, D. Chakraborty, A. Torbert. 2021. Effects of gypsum-amended poultry litter on nutrient release and water quality. Poster Presentation. ASA-CSSA-SSSA International Annual Meeting. Salt Lake City, UT. Nov 7-10, 2021. (*Awarded best poster*)
9. *Powell, A., **R. Prasad**, D. Watts, D. Chakraborty, A. Torbert. 2021. effects of gypsum-amended poultry litter on nutrient release and crop yield. Poster Presentation. ASA-CSSA-SSSA International Annual Meeting. Salt Lake City, UT. Nov 7-10, 2021.
10. *Bhatta, A., **R. Prasad**, D. Chakraborty, D. Watts, and A. Torbert. Determination of phosphorus loss in runoff from soils with different soil test phosphorus ratings. Oral Presentation. ASA, CSSA, SSSA International Annual Meeting. Salt Lake City, ID. Nov 7-10, 2021.
11. *Sidhu, N.S., **R. Prasad**, D. Chakraborty. 2021. Understanding the variation in phosphorus pools with time in Alabama soil regions. Poster Presentation. ASA-CSSA-SSSA International Annual Meeting. Salt Lake City, ID. Nov 7-10, 2021.
12. *Sharma, A., **R. Prasad**, A.T. Nguyen, A. Bhatta, B. Ortiz, A. Gamble, M. Worosz, L. Duzy. 2021. Understanding nutrient balances of commercial row crop fields in Alabama. Poster Presentation. University- College of Agriculture Graduate Student Research Poster Showcase. Auburn, AL. Oct 28, 2021. (*Awarded Best Poster*).
13. Nguyen, A.T., **R. Prasad**, A. Sharma,* A. Bhatta,* B. Ortiz, A. Gamble, M. Worosz, and L. Duzy. 2022. Monitoring Sediment and Nutrient Losses from Paired Watersheds in Agriculture Fields in Alabama Farms. Poster presented during the Future of Farming Research Symposium, College of Agriculture, Alabama Cooperative Extension System, Alabama Agricultural Experiment Station, 12 Sep.
14. Sharma, A.,* **R. Prasad**, A.T. Nguyen, A. Bhatta,* B. Ortiz, A. Gamble, M. Worosz, and L. Duzy. 2022. Runoff Nutrient Losses from Row Crop Fields in Alabama. Poster presented during the Future of Farming Research Symposium, College of Agriculture, Alabama Cooperative Extension System, Alabama Agricultural Experiment Station, 12 Sep.
15. Sharma, A., **R. Prasad R**, Nguyen A.T., Ortiz B, Gamble A., Worosz M.R., Duzy L. Runoff nutrient losses from unfertilized soybean crop. Alabama Water Conference, Orange beach, USA. Sept 6-7, 2022
16. Nguyen, A.T., **R. Prasad**, A. Sharma,* B. Ortiz, A. Gamble, M.R. Worosz, and L. Duzy. 2022. Monitoring sediment and nutrient losses from paired watersheds in agriculture fields in Alabama farms. Poster presented during Water Conference, Orange beach, USA. Sept 6-7, 2022.

Extension Presentations

1. **Prasad, R.**, 2022. The Beckoning Phosphorus. American Association of Plant Food Control Officials Winter Annual Meeting. Mobile, AL. Feb 15, 2022. (Number of attendees: 50). *Invited presentation*.
2. **Prasad, R.** 2022. Benefits of broiler litter in row crops. Jacksonville Crop Production Meeting. Jacksonville, AL. March 3, 2022. (Number of attendees: 15).
3. **Prasad, R.** 2022. Revisiting broiler litter as a fertilizer – Applications for my operation. Annual Alabama Cattlemen's Association Convention. Mobile, AL. March 4th, 2022. (Number of attendees: 15). *Invited presentation*.

4. **Prasad, R.** 2022. Nutrient management program at Auburn University- an overview. Nutrient Management Spear Program, Cornell University. Online. March 21st, 2022. (Number of attendees: 12). Invited presentation.
5. **Prasad, R.** 2022. Gypsum poultry Litter use. Agricultural Research Service. FGD Gypsum Research Meeting. Online. March 1, 2022. (Number of attendees: 10).
6. **Prasad, R.** 2022. Use of poultry litter & soil testing. Monthly Beef Management Meeting. Montgomery County Extension Office, Montgomery, AL. Jan 3, 2022. (Number of attendees: 12).
7. **Prasad, R.** 2022. Development of practices to reduce nutrient losses to the environment from land application of animal waste & by-products. Senate Ag Appropriations Subcommittee. Auburn, AL. April 14th, 2022 (Number of attendees: 10).
8. **Prasad, R.** 2022. Development of practices to reduce nutrient losses to the environment from land application of animal waste & by-products. Online, USDA ARS. April 28th, 2022 (Number of attendees: 8).

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

We have disseminated information and knowledge gained from our projects to a broader audience using several instruments. For example, we provided regular updates on our project using social media platforms such as Facebook. We have developed and maintained Alabama Extension Animal Waste and Nutrient Management Facebook page. The link can be found here: <https://www.facebook.com/AWandNM>. The page is followed by 424 members (347% increase in followers since 2018) and has 1099 page visits, not within the US but also in countries like Canada, Nepal, Bangladesh, Africa, India, Brazil, Costa Rica, Egypt, Portugal, and Thailand. In 2022, we had 15 posts throughout the year with a reach of 5226 people. We also disseminated information through field days hosted at Alabama Experiment stations, farmer's meetings, extension publications, podcasts, and youtube video.

Podcast

1. **Prasad, R.** 2022. Using poultry litter. Season 2 Episode 1. [Alabama Crops Report Podcast](#). Mar 10, 2022).

Youtube Videos

1. *Powell, A., and **R. Prasad**. 2022. [Poultry litter use within cotton production](#). Alabama Cooperative Extension System Video.
2. **Prasad, R.** 2022. [Research updates from Wiregrass station](#). Alabama Cooperative Extension System Video.
3. *Singh, R., and **Prasad, R.** 2022. [Research updates from E.V. Smith station](#). Alabama Cooperative Extension System Video.

Closing Out (end date 03/06/2024)

Improving economic and environmental sustainability in tree fruit production through changes in rootstock use

Project Director

Elina Coneva

Organization

Auburn University

Accession Number

1019461



Improving economic and environmental sustainability in tree fruit production through changes in rootstock use

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

Armillaria root rot (ARR) disease caused by a soilborn fungus (*Armillaria tabescens*) is the second leading cause of peach tree mortality in the southeastern United States with estimated production losses averaging more than \$8 million annually. Currently available chemical controls are not considered to be cost effective. Guardian® is presently the dominant rootstock for the southeastern peach industry primarily due to its superior tolerance to peach tree short life (PTSL). However, Guardian® is highly susceptible to the ARR pathogen. 'MP-29' is a recently (2011) released clonal interspecific hybrid peach rootstocks that provides superior resistance to ARR without the adverse effect on scion fruit size and productivity. Studies are designed to compare rootstock tolerance to ARR and evaluate tree size, phenological development, yield, and fruit quality of selected peach cultivars grafted on 'MP-29' and Guardian® (standard) rootstocks, at a site with documented ARR history at the Chilton Research and Extension Center near Clanton, AL.

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 established experimental blocks with a variety of peach cultivars grown under different production systems, namely high-density planting with a perpendicular-V training system, peach trees grown in containers, and the conventional low density open vase training system which is predominantly utilized in the state. Data collection and detailed evaluations continued through the reporting period and the annual results were analyzed. Outcomes continue to provide evidence of the advantages of utilizing the size controlling, disease resistant MP-29 rootstock for sustainable peach production in Alabama conditions.

Studies also continued to assess the cropping potential and production efficiency of eight newly developed size-controlling peach rootstocks grafted to 'Cresthaven' peach and trained to a perpendicular V training system and determine the system feasibility for establishment of high-density peach orchard system in Alabama. We harvested the trees and evaluated the rootstock effect on total yield, and fruit quality of 'Cresthaven' peach. Studies continued to: 1). Compare two rootstock cultivar resistance to Armillaria Root Rot (ARR) in open field environment; 2). Compare the effect of two peach rootstocks on ARR resistance in potted medium; 3). Evaluate six advanced peach selections with improved bacterial spot resistance and early ripening from Clemson University's peach breeding program.

The Fire Blight (FB) resistant European pear cultivars planted at the Chilton REC, near Clanton produced a good crop this season. Data was generated to evaluate and compare yield and fruit quality of the 9 FB resistant European pear selections and cultivars imported from Canada. Research also continued to evaluate 9 FB resistant Asian pear cultivars.

We have continue to generate data for the hybrid bunch grape rootstock study at the CREC where we compare the Pierce's Disease resistance, growth and development of two own-rooted versus grafted American hybrid bunch grape cultivars. Other outputs include investigations to assess the vegetative and cropping potential of two sets of Pierce's Disease resistant 87.5% and 94% *V. vinifera* (European) selections developed at the U.C. Davis, CA. Additionally, we investigate the performance of European grapes on two training systems: Vertical Shoot Position (VSP) and Watson trellis systems.

Activities also included advising a MS student conducting research experiments relevant to temperate zone fruit tree rootstock projects. Integrated events included participation and giving presentations at professional meetings and industry focused meetings. Sixteen presentations on research results generated by experiments listed above were given at national and regional conferences including the Southern Region of the American Society for Horticultural Science (SRASHS) Annual Meeting, the American Society for Horticultural Science (ASHS) Annual Meeting, National Association of County Agricultural Agents (NACAA), SE Professional Fruit Workers.

Presentations of research updates were made for the Alabama Fruit and Vegetable Growers Association (AFVGA) Annual Conference, Chilton County Peach Production Meeting, Southeast Regional Fruit and Vegetable Conference in Savannah, GA, NACAA&PD, and through a series of webinars hosted by the Commercial Horticulture team at the ACES.

Research papers based on the above listed experimental activities were also submitted to two international symposia namely: XXXI International Horticulture Congress in Angers, France and the X International Peach Symposium in Naoussa, Greece.

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

Attended and presented two research posters and contributed to a talk at the Southeast Regional Fruit and Vegetable Conference, Savannah, GA; presented six papers at the SR American Society for Horticultural Science Annual Meeting; five presentations at the American Society for Horticultural Science Annual Meeting; a paper at the National Association of County Agricultural Agents. A presentation was made at the Alabama Fruit and Vegetable Growers Association Annual Conference;

three presentations at the Professional Ag Workers Conference, Montgomery, AL. Presentations were made at the Chilton Area Peach Production Meeting, Clanton. Training events for the Commercial Horticulture extension personnel also included a series of webinar presentations. Hands-on workshops and demonstrations on sustainable fruit production methods were offered to commercial producers and general public. Four graduate students were trained during the reporting period.

Journal Articles:

Minas, I.S., Reighard, G.L., Black, B., Cline, J.A., Chavez, D.J., Coneva, E., Lang, G.A., Parker, M., Robinson, T.L., Schupp, J., Francescato, P., Lordan, J., Beckman, T., Shane, W.W., Pieper, J.R., Sterle, D.G., Bakker, C., Clark, B., Ouellette, D., Swain, A. and Winzeler, H.E. (2022). Establishment performance of the 2017 NC-140 vigor-limiting peach rootstock trial across ten sites in North America. *Acta Hort.* 1346, 669-676. DOI: 10.17660/ActaHortic.2022.1346.84

<https://doi.org/10.17660/ActaHortic.2022.1346.84>

Reighard, G.L. (2022). Thirty-three years evaluating rootstocks for peach in the NC-140: what have we learned. *Acta Hort.* 1346, 655-660

DOI: 10.17660/ActaHortic.2022.1346.82

<https://doi.org/10.17660/ActaHortic.2022.1346.82>

Jacob T. Kelley, James D. Spiers, J. Raymond Kessler, Elina D. Coneva, and Edgar L. Vinson. 2022. Effect of Hydrogen Cyanamide on Flower Production of 'AU Golden Sunshine' and 'AU Gulf Coast Gold' Kiwifruit. *J. Am. Pom. Soc.*, 76 (2): 59-66.

Five-year Evaluation of Selected Strawberry (*Fragaria X ananassa* Duch.) Cultivars for Improved Sustainability of the Strawberry Industries in Alabama and the South Atlantic Region of the United States. 2022. Edgar L. Vinson II, Penelope A. Perkins-Veazie, Eugene K. Blythe, Elina D Coneva, and Matthew D. Price, *J. Am. Pom. Soc.* 76 (3):114-124.

Abstracts:

Vinson E, Perkins-Veazie P, Coneva E, Blythe E, Price M. 2022. Organoleptic Attributes of Best Adapted Strawberry Cultivars for Alabama (abstr). *HortScience* 57(9):S273. <https://doi.org/10.21273/HORTSCI.57.9S.S1>

Coneva E. 2022. Assessment of MP-29 Rootstock for Potted Peach Production (abstr). *HortScience* 57(9):S267.

<https://doi.org/10.21273/HORTSCI.57.9S.S1>

Coneva E. 2022. Size-controlling Apple Rootstocks for High Density Orchards in Alabama (abstr). *HortScience* 57(9):S266.

<https://doi.org/10.21273/HORTSCI.57.9S.S1>

Elina Coneva, E.L. Vinson, and M. Salazar-Gutierrez. 2022. Effect of Planting Distance on Yield and Fruit Quality of PD Resistant Predominantly *Vitis vinifera* Grapevine. SR ASHS, New Orleans, LA, February 11-13, 2022.

Coneva E. 2022. Evaluation of Size-controlling, Pest Resistant Peach Rootstocks for Alabama (abstr). *HortScience* 57(9):S250.

<https://doi.org/10.21273/HORTSCI.57.9S.S1>

Majumdar A, Chambliss A, Willis H, Sikora E, Kesheimer K, Pickens J, Vinson E, Coneva E, Kembler J, da Silva A, Rodrigues C, Han D, Prasad R, Gamble A, Li S, Rabinowitz A, Jacobi J, Conner k, Thomas S, Ulmer M, Chaves-Cordoba B. 2022. How Alabama Extension Commercial Horticulture Program Team Utilized Social Media and Evaluation Metrics for Virtual Event Planning Through the COVID-19 Pandemic (abstr). *HortScience* 57(9):S239. <https://doi.org/10.21273/HORTSCI.57.9S.S1>

Coneva E. 2022. Determining the Feasibility of 'MP-29' Rootstock for Container Peach Production (abstr). *HortScience* 57(9):S91. <https://doi.org/10.21273/HORTSCI.57.9S.S1>

Coneva E. 2022. Effect of Size-Controlling 'MP-29' Rootstock on 'Julyprince' and 'Bounty' Peaches (abstr). *HortScience* 57(9):S92. <https://doi.org/10.21273/HORTSCI.57.9S.S1>

Vinson E, Sanz-Saez A, Coneva E, Salazar-Gutierrez M, Blythe E, Price M. 2022. Low Tunnel Plasticulture Use in Strawberry Production (abstr). *HortScience* 57(9):S138. <https://doi.org/10.21273/HORTSCI.57.9S.S1>

Majumdar A, Chambliss A, Willis H, Pickens J, Vinson E, Coneva E, Kembler J, daSilva A, Chaves-Cordoba B, Rodrigues C. 2022. Social Media and Evaluation Metrics for Virtual Events through the COVID-19 Pandemic (abstr). *HortScience* 57(9):S165.

<https://doi.org/10.21273/HORTSCI.57.9S.S1>

McWhirt A, Samtani J, Fernandez G, Stafne E, Coneva E, Lockwood, Havlin J, Rubio Z. 2022. Status of Blackberry Fertility Management in the Southeast: Surveys of Grower Practices and Leaf Tissue Nutrient Content (abstr). *HortScience* 57(9):S9.

<https://doi.org/10.21273/HORTSCI.57.9S.S1>

Jarrett Price, Elina Coneva, Melba Salazar-Gutierrez, Edgar Vinson, Sushan Ru and Bernardo Chaves-Cordoba. 2022. Planting Distance Can Increase the Yield of PD Resistant Predominately *Vitis Vinifera* Grapevine '502-20'. Southeastern Professional Fruit Workers Conference, Lake Alfred, FL.

Elina D. Coneva, Sushan Ru, Edgar Vinson and Melba Salazar. 2022. Assessing New Rabbiteye Blueberry Cultivars for Central Alabama. Professional Agricultural Workers Conference (PAWC), Montgomery.

Elina D. Coneva. 2022. Newly Released Muscadine Cultivars Evaluation. Professional Agricultural Workers Conference (PAWC), Montgomery.

Greg Reighard, Dario Chavez, Elina Coneva, Mike Parker. 2022. Performance of semi-dwarfing peach rootstocks for high density plantings in the Southeastern states. Southeast Regional Fruit and Vegetable Conference, Savannah, GA, January 6-9.

Elina Coneva. 2022. Assessment of Armillaria Root Rot Resistant Rootstock 'MP-29' for Sustainable Peach Production in Alabama. X International Peach Symposium, Naoussa, Greece, 2022. Book of Abstracts, P. 114:

<https://www.fruitsciences.eu/peach2021/files/book-of-abstracts.pdf>

Elina Coneva and Bernardo Chaves-Cordoba. 2022. '1103 Paulsen' Rootstock Increases Yield and Fruit Quality of 'Chardonel' Grape in Alabama Growing Conditions. Southeastern Professional Fruit Workers Conference, Lake Alfred, FL.

Elina Coneva and Bernardo Chaves-Cordoba. 2022. Investigating the Feasibility of 'MP-29' Rootstock for Container Peach Production. Southeastern Professional Fruit Workers Conference, Lake Alfred, FL.

Elina Coneva and Ksenija Gasic. 2022. Assessment of Bacterial Spot Tolerant Advanced Peach Selections in Alabama. Southeastern Professional Fruit Workers Conference, Lake Alfred, FL.

Elina Coneva and Bernardo Chaves-Cordoba. 2022. Utilizing Size-Controlling and Disease Resistant 'MP-29' Rootstock for Sustainable Peach Production in Alabama. Southeastern Professional Fruit Workers Conference, FL.

Elina D. Coneva. 2022. 1103 Paulsen' Rootstock Increases Yield and Fruit Quality of 'Chardonel' in Alabama Conditions. ASEV-ES Annual Conference, MN, July13-15, 2022.

Elina D. Coneva. 2022. '1103 Paulsen' Rootstock Increases Yield and Fruit Quality of 'Chardonel' Grape in Alabama Growing Conditions. Book of Abstracts, XXXIst International Horticultural Congress, France.

Elina Coneva and Ksenija Gasic. 2022. Assessment of Bacterial Spot Tolerant Advanced Peach Selections in Alabama. NACAA PD&AM, FL, July 17-22.

Elina D. Coneva. 2022. Investigating Rootstocks for Container Peach Production, Professional Agricultural Workers Conference, Montgomery.

Elina Coneva and Ksenija Gasic. 2022. Assessment of Bacterial Spot Tolerant Advanced Peach Selections in Alabama. Alabama Association of Agricultural County Agents and Specialists (ACAAS) AM&PD Conference.

Elina D. Coneva, E.L. Vinson, and M. Salazar-Gutierrez. 2022. Developing a Technology for Production of Pierce's Disease Resistant *Vitis vinifera* Grapes. Southeast Regional Fruit and Vegetable Conference, Savannah, GA, January 6-9.

Elina Coneva and Ksenija Gasic. 2022. Evaluation of Bacterial Spot Tolerant Advanced Peach Selections for Alabama Conditions. Southeast Regional Fruit and Vegetable Conference, Savannah, GA, January 6-9.

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

Made contributions through Websites, webinars, conferences, Live Facebook CommHort events, You Tube video, Alabama IPM Communicator Newsletter, Southern Region Small Fruit Consortium Newsletter, Beginning Farmer App Module Courses; Blog articles through the ACES; hands-on and demonstration field days.

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.

Some of the challenges during the reporting period include the freeze damage to some of the peach accessions which prevented us to evaluate the full cropping potential. The severe bacterial spot infection impeded the amount of marketable fruit. The program also experienced shortage of labor in the peak of the season, but we managed to collect all of the planned data for the season. The lab is planning to hire a student worker to assist in plot management, harvest of experiments and data recording next season.

Soil Health Research in Alabama Row Crop Systems

Project Director

Audrey Gamble

Organization

Auburn University

Accession Number

1017954



Soil Health Research in Alabama Row Crop Systems

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

Many soils across Alabama have low water- and nutrient-holding capacities due to warm climate, coarse-textured soils, and intensive farming practices traditionally used in the state. Soil conservation practices such as cover cropping and reduced tillage have potential to improve soil health, reduce erosion, and increase water-use efficiency while maintaining/increasing productivity. Research outlined in this proposal is targeted to improve knowledge of soil conservation practices for southeastern soil types. The objectives of this proposal are 1) to evaluate the effects of conservation agronomic practices (e.g., cover cropping) to improve soil health and productivity of Alabama soils and 2) to assess short-term soil health indicators for their ability to predict long-term improvements in soil health.

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

Over 30 research trials have been established since 2017 in various Alabama soil types to examine the impact of soil conservation practices (i.e., cover cropping, conservation tillage, nutrient management) on soil health and crop productivity. Studies have demonstrated that small grain and legume cover crops have potential to increase soil organic matter content and reduce soil compaction while maintaining or improving yield of cash crops (i.e., cotton, soybean, and peanut) in Alabama cropping systems. Research has also demonstrated optimal cover crop seeding rates, planting dates, and variety selection needed for farmers to increase cover crop benefits on their farms.

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

Results have been disseminated to scientific communities through presentations at regional and national meetings. Three abstracts were presented at the 2022 ASA-CSSA-SSSA conference in Baltimore, MD. Abstracts were also presented at the 2022 American Society of Agronomy Southern Branch meeting in New Orleans, LA, the 2022 Beltwide Cotton Conference in San Antonio, TX, and the 2022 American Peanut Research and Education Society Meeting in Dallas, TX. Three cover crop field days were organized by the PI in 2022 in north, central, and south Alabama. Results were also presented by the PI at numerous county and state-wide production meetings to present results to producers, USDA-NRCS employees, Extension employees, and industry personnel in Alabama.

Peer-Reviewed Publications († - indicates a graduate student advised by Gamble):

1. Bagnall et al. 2022. (**Gamble, A.V.** is author 39 of 108). Selecting soil hydraulic properties as indicators of soil health: Measurement response to management and site characteristics. *Soil Sci. Soc. Am. J.* doi.org/10.1002/saj2.20428
2. Liptzin et al. 2022. (**Gamble, A.V.** is author 37 of 108). An evaluation of carbon indicators of soil health in long-term agricultural experiments. *Soil Biol. Biochem.* doi.org/10.1016/j.soilbio.2022.108708

3. †Decker, H., **AV. Gamble**, A.M. Johnson, and K.S. Balkcom. Cover crop monocultures and mixtures impact soil health indicators in the Southeast U.S. *Soil Sci. Soc. Am. J.* doi.org/10.1002/saj2.20454
 4. Bagnall et al. 2022. (**Gamble, AV.** is author 36 of 107). Carbon-sensitive pedotransfer functions for plant available water. *Soil Sci. Soc. Am. J.* doi.org/10.1002/saj2.20395
 5. Rieke et al. 2022. (**Gamble, AV.** is author 39 of 106). Linking soil microbial community structure to potential carbon mineralization: A continental scale assessment of reduced tillage. *Soil Biol. Biochem.* 108618 doi:10.1016/j.soilbio.2022.108618
 6. †Crowell, H., **AV. Gamble**, Y. Feng, K.S. Balkcom, and A. Yang. 2022. Impacts of winter grazing on soil health in southeastern cropping systems. *Agrosystems, Geosciences & Environment.* doi: 10.1002/agg2.20240
- Abstracts for National and International Meetings († - indicates a graduate student advised by Gamble):
1. †Reiter, W., **AV. Gamble**, H. Crowell, Y. Feng, and K.S. Balkcom. 2022. Effects of Grazing Winter Cover Crops on Soil Health in the Southeastern U.S. 2022 American Society of Agronomy International Meeting, Baltimore, MD.
 2. †Galloway, L., **AV. Gamble**, E. Guertal, and Z. Ogles. 2022. Nitrification Inhibition Potential of Ammonium Thiosulfate and Potassium Thiosulfate. 2022 American Society of Agronomy International Meeting, Baltimore, MD.
 3. **AV. Gamble**, A. Kumari, S. Seehaver, A. Blount, C. Chase, J. Gaskin, C. Reberg-Horton, and K.S. Balkcom. 2022. Southern Cover Crops Council Multi-State Trials: Winter Annual Cover Crop Variety Selection and Seeding Rates for the South. 2022 American Society of Agronomy International Meeting, Baltimore, MD.
 4. **Gamble, AV.**, H.L. Decker, A.M. Johnson, and K. Balkcom. 2022. Cover Crops Impact Soil Health and Peanut Production in Alabama. 2022 American Peanut Research and Education Society Meeting. Dallas, TX.
 5. **Gamble, AV.** 2022. Soil Health Testing in Alabama. 2022 Southern Extension and Research Activity Soil Testing Meeting. Nashville, TN.
 6. †Decker, H. L., A.M. Johnson, **AV. Gamble**, and K.S. Balkcom. 2022. Cover crop influence on soil health and cotton production in Alabama. Beltwide Cotton Conference. San Antonio, TX.
 7. †Rose, E.O., and **AV. Gamble**. 2022. Nitrogen Sources for Alabama Cotton Production Systems. Beltwide Cotton Conference. San Antonio, TX.
 8. †Johnson, A. J., Decker, H., Balkcom, K., and **Gamble, AV.** 2022. Evaluation of cover crop monocultures and mixtures for soil health. ASA Southern Branch Annual Meeting. New Orleans, LA.

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

My project seeks to increase adoption of soil conservation practices by Alabama farmers. Results from my research program are used to create Extension programming to improve farmer knowledge on managing cover crops to achieve soil health benefits. Increased adoption of soil conservation practices (e.g., cover cropping and conservation tillage) benefits the general public by protecting valuable soil and water resources. For example, cover crops help to prevent soil erosion and reduce nutrient runoff, thereby reducing pollution of surface water sources. In addition, cover crops can improve soil carbon sequestration and help mitigate climate change.

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

Seven graduate students have completed MS degrees related to the current Hatch project from 2017-2022. All graduate students, as well as several undergraduate students, have been trained in each of the following areas: soil and plant sample collection, lab analyses, data management, data analysis, and analytical writing. All graduate students have given presentations on their research with 1) the scientific community at national and regional conferences and 2) with farmers and crop consultants at Extension production meetings.

Renewing an Agriculture of the Middle: Value Chain Design, Policy Approaches, Environmental and Social Impacts

Project Director

Michelle Worosz

Organization

Auburn University

Accession Number

1016940



Renewing an Agriculture of the Middle: Value Chain Design, Policy Approaches, Environmental and Social Impacts

Final Result

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

Generally, this project concerns the viability of mid-sized farms in the U.S., which have been declining for decades. One option is to increase the number and type of opportunities to engaged in alternative supply chains and markets. This sub-project is part of a larger multi-state Hatch (NC1198) and the focus includes understanding the rules that create barriers, constraints, and opprtunities for the development of the values-based supply chains, especially, but not limited to, food safety and environmental policies. A critical place in which these rules emerge is in the conduct of the science itself, and in relationships among researcher, extension professional, and stakeholders.

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.

Values-based supply chains were examined by looking at how consumer sought food when commercial supply chains were compromised (i.e., did they gravitate toward alternative, values-based, supply chains and/or local foods?). Food security was examined by looking at how low income consumers percieve federal feeding programs such as food boxes (i.e., could "acceptable" food boxes be designed at the community level, and thus feeding programs become less centralized). The relationships among front-end supply chain actors were examined by looking at team-based science and stakeholder engagement (i.e., can "transdisciplinary approaches yield the adoption of resilient and environmentally sound production practices).

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

Food reformers learn how consumers seek food during disruptions and the strategies that might best serve those who are low income and food insecure. Producers and extension professionals learn how to design and implement climate-smart technologies, whereas scientists learned how to engage stakeholderw to identify on-farm needs and manage barriers to the transfer of technology.

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

Consumers, in general, can benefit from changes to the food systems including more stable local food supply chains, whereas those who are low-income and food insecure can benefit from access to alternative food sources that meet cultural norms and expectations. In addition, the broader public benefits from transdisciplinary science and enhaned engagement when producers are able to adopt technologies that reduce environmental burdens such as nutrient run-off and inefficient water usage (i.e., adoption of climate-smart agriculture).

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.

Major changes or problems: the work has gravitate toward concerns about transdisciplinarity as the issues of the declining middle, food security, and climate resiliene are "wicked problems." Wicked problems require new ways understanding, new methods of investigation, and new burdens on stakeholders.

Opportunities for training and professional development: two M.S. students graduated with one taking a position as Communications Director with the Precision Sustainable Agriculture Network at North Carolina State University; and the other as an Associate Program Officer with the National Academies of Sciences on the Board on Environmental Change and Society. I completed a year-long engagement workshop that increased my team-based science capacity and contributed to my development of a graduate-level Extension Methods course. In addition, this work increased the research teams' capacity to use novel methods of engagment with stakeholders who are not accustomed to the co-development of knowledge approach.

Dissemination of results (see specifics below): results have been desimminated at many professional meetings for extension and acedemia, as well has several outreach meetings with stakeholders.

Project plans: complete the food security food box project; continue to work on transdisciplinarity, especially the incorporation of stateholders in the development and transfer of technology; and start new study of the contribution of non-profit farms to local food systems.

Peer-Reviewed Publications

Peer-Reviewed Publications

- Eaton, W.E., M. Burnham, T. Robertson, J.G. Arbuckle, K.J. Brasier, M.E. Burbach, S.P. Church, G. Hart?Fredeluces, D. Jackson?Smith, G. Wildermuth, K.N. Canfield, S.C. Córdoba, C.D. Chatelain, L.B. Fowler, M.M.Z. elAbdeen Hendawy, C.J. Kirchhoff, M.K. Manheim, R.O. Martinez, A. Mook, C.A. Mullin, A.L. Murrah?Hanson, C.O. Onabola, L.E. Parker, E.A. Redd, C. Schelly, M.L. Schoon, W.A. Sigler, E. Smit, T. van Huysen, M.R. Worosz, C.Eberly, A. Rogers. 2022. *Advancing the scholarship and practice of stakeholder engagement in working landscapes: A co-produced research agenda*. Socio-Ecological Practice Research. (DOI: 10.1007/s42532-022-00132-8).
- Worosz, M.R. 2022. *Transdisciplinary research for wicked problems*. **Invited**. Agriculture and Human Values, Volume 39, Issue 4. (DOI: 10.1007/s10460-022-10371-w).
- Dupuis, M., E. Ransom, and M.R. Worosz. 2022. *The new consumer and media attention to local food systems in COVID-19, will it last?* Frontiers in Sustainable Food Systems, 6 (DOI: 10.3389/fsufs.2022.836574). [Authorship is shared equally].

Papers Currently Under Review

- Thomson, R. R. Moiser, M.R. Worosz. 2022. *COVID research across the social sciences*. Manuscript submitted to Scientometrics.

Manuscripts In-Process

- Stewart, H., M.R. Worosz, R. Thomson, M. Robinette, B. Ortiz, A. Gamble, L. Duzy, R. Prasad. *The challenges of co-developing climate-resilient strategies, practices, and technologies among research and extension teams*. Manuscript to be submitted to Journal of Extension.
- Olive, L. and M.R. Worosz. *Better than Blue Apron: Foodwork recognized and redefined to include the perspectives of Black women*. Manuscript submitted to the Journal of Hunger and Environmental Nutrition.

Non-Peer Review and Outreach Publications

- Eaton, W., T. Robertson, J. Arbuckle, K. Brasier, M. Burbach, M. Burnham, S. Church, C. Eberly, G. Hart-Fredeluces, D. Jackson-Smith, A. Rogers, G. Wildermuth, K. Canfield, S.C. Córdova, C. Chatelain, J. Edwards, L. Fowler, Z. Hurst, C. Kirchhoff, M. Manheim, R. Martinez, A. Mook, C. Mullin, L. Murrah-Hanson, C. Onabola, L. Parker, E. Redd, C. Schelly, M. Schoon, W.A. Sigler, E. Smit, T. van Huysen, L. Verbrugge, M. Worosz, 2022. *Advancing the Scholarship and Practice of Stakeholder Engagement in Working Landscapes: 34 Co-produced Research Opportunities*. (DOI: 10.26207/b8rt-5q47).

Research Presentations

- **Future of Farming Research Symposium**, College of Agriculture, Alabama Cooperative Extension System, Alabama Agricultural Experiment Station, 12 Sep 2022 (40 participants).
 - Nguyen, A.T., R. Prasad, A. Sharma, A. Bhatta, B. Ortiz, A. Gamble, M. Worosz, and L. Duzy. *Monitoring Sediment and Nutrient Losses from Paired Watersheds in Agriculture Fields in Alabama Farms*.
 - Sharma, A., R. Prasad, A.T. Nguyen, A. Bhatta, B. Ortiz, A. Gamble, M. Worosz, and L. Duzy. *Runoff Nutrient Losses from Row Crop Fields in Alabama*.
 - Worosz, M.R. *The Challenges of Co-Developing Knowledge about Climate-Smart Technology: A Preliminary Analysis of an NRC CIG Project*.
 - Robinette, M., R. Thomson, H. Stewart, B. Ortiz, A. Gamble, L. Duzy, and R. Prasad. “*There’s Not a One Size Fits All:*” *Developing Sites Specific and Farmer Focused Extension Programming*.
- **Alabama Water Conference**, Orange Beach, AL, 06-07 Sep, 2022.
 - Sharma, A., R. Prasad, A.T. Nguyen, B. Ortiz, A. Gamble, M.R. Worosz, and L. Duzy. *Runoff Nutrient Losses from Unfertilized Soybean Crop*.
 - Nguyen, A.T., R. Prasad, A. Sharma, B. Ortiz, A. Gamble, M.R. Worosz, and L. Duzy. *Monitoring Sediment and Nutrient Losses from Paired Watersheds in Agriculture Fields in Alabama Farms*.
- **Rural Sociological Society**, Westminster, CO, 04 - 07 Aug, 2022.
 - Robinette, M., M.R. Worosz, R. Thomson, and H. Stewart. 2022. *Reviving Loomis: A Classical Approach to Modern Agricultural Extension*.
- **Agriculture and Human Values Society** and the **Association for the Study of Food and Society** (ASFS), Athens, GA, 18 - 22 May, 2022.
 - Worosz, M.R., H. Stewart, M. Robinette, B. Ortiz, A. Gamble, L. Duzy, and R. Prasad. 2022. *Doing Co-Development*.
 - Dupuis, M., M.R. Worosz, and E. Ransom. 2022. *Local Food System Response to Food Supply Shocks during COVID-19*.
- **International Agricultural and Extension Education**, Thessaloniki, Greece, 04-07 April, 2022.
 - Stewart, H., M.R. Worosz, M. Robinette, B. Ortiz, A. Gamble, L. Duzy and R. Prasad. 2022. *Climate-Based Convergence Strategies to Facilitate Sustainable Learning Among Row Crop producers and agricultural stakeholders*.

- o **Southern Rural Sociological Association** (SRSA) section of the annual meetings of the **Southern Association of Agricultural Scientists**, New Orleans, LA, 13-14 Feb, 2022.

- Robinette, M.R., M.R. Worosz, H. Stewart, B. Ortiz, A. Gamble, L. Duzy and R. Prasad. *“Climate -Smart” Information Exchanges in the Future of Farming.*

- Stewart, H., M.R. Worosz, M. Robinette, B. Ortiz, A. Gamble, L. Duzy, and Rishi Prasad. *Co-Developing Climate-Smart Strategies for Alabama Row Crop Producers and Agricultural Stakeholders.*

- o **College of Agriculture** Poster Showcase. Auburn University, Auburn, AL, 28 Oct, 2021.

- Sharma, A., R. Prasad, A.T. Nguyen, A. Bhatta, B. Ortiz, A. Gamble, M. Worosz, L. Duzy. *Understanding Nutrient Balances of Commercial Row Crop Fields in Alabama.*

- Robinette, M. M.R. Worosz, R. Thomson, H. Stewart. *The Strength of Weak Ties Among Alabama Row Crop Stakeholders.*

- Stewart, H., M.R. Worosz, and M. Robinette. *Identifying Climate-Smart Needs and Opportunities.*

Outreach Presentations

- o Worosz, M.R., H. Stewart,* M. Robinette,* B. Ortiz, A. Gamble, L. Duzy, R. Prasad. 2022. *Interest in Collaboration to Co-Develop Climate-Smart Technology.* Poster presented at the 44th Annual Central Alabama Crops Tour, Alabama Cooperative Extension Service, Lazenby Farms, 11 Aug (71 participants).

- o Worosz, M.R. 2022. *Rural Sociology, Agrifood System Supply Chains, and Climate-Smart Technology.* **Invited** presentation during the Auburn University NSF Research Traineeship Immersion Experience, Weeks Bay, AL, 06 Aug (21 participants).

- o Worosz, M.R. 2022. *Rural Sociology and the CIG Project.* **Invited** presentation during the Inaugural Auburn University Climate Event, NSF NRT program and the AU Office of Sustainability, 22 March (70 participants, <https://sustain.auburn.edu/event/climate-symposium/>).

Critical Issue

Human Nutrition, Well-being, Health and Obesity

Perception of the Barriers and Benefits of Consuming a Vegetarian Diet in Madison County, Alabama Residents

Project Director

Rhona Miller-Cebert

Organization

Alabama A&M University

Accession Number

7002678



Perception of the Barriers and Benefits of Consuming a Vegetarian Diet in Madison County, Alabama Residents

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

As the minority population grows in the United States, it is expected that health disparities will continue to overwhelm this group of citizens who suffers disproportionately from diet-related preventable diseases. Traditionally, research has focused on nutrient deficiencies as they relate to vegetarian diets, but not enough attention is given to educating minority communities on appropriately planned optional diets that may prevent the adverse health outcomes that are concentrated in minority communities. Although vegetarian diets have been practiced for years and are now becoming more appealing and accessible, minority communities are not fully informed of the impact of such diets on health outcomes.

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

A health fair was held at the Bob Harrison Advocacy and Wellness Center in Huntsville, Alabama. This health fair was organized in collaboration with the College of Agricultural Life and Natural Sciences Mobile Health Clinic Team. A healthcare team from Ross Medical and a local practitioner was on site to carry out wellness screenings such as blood pressure check, hemoglobin and blood glucose screening, and COVID-19 tests and vaccines. Healthy meals were prepared and served by faculty members and students from the Family and Consumer Sciences department, area of Nutrition and Hospitality Management. Approximately thirty individuals attended the event. Recipe cards of the meals served were made available to each attendee.

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

The participants who attended the event had an opportunity to interact directly with the clinical personnel on site who generously answered their questions. They were able to compare the screening results from the health fair with the results from their healthcare provider to see if there were improvements. The nutrition professionals were also available to answer nutrition-related questions.

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

As participants share the information gained from the event and make better diet and lifestyle choices, we anticipate that they will achieve better health with a more positive outlook on life.

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.

Although we are "on the other side" of the COVID-19 pandemic, the project team was not successful in reaching some of the individuals who attended previous project events. Some individuals were very concerned about being in public and chose not to attend the health fair. The next health is being planned in an outdoor setting, and we anticipate that this may attract more participants.

Students from the area of nutrition and hospitality management participated in the preparation of meals and in the development of the recipe cards. The students were also on site to share nutrition information with participants and to direct them to appropriate personnel. These events continue to train students in providing nutritionally sound meals and exposure to community nutrition.

Urban Youth STEAM Academy

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7004653



Urban Youth STEAM Academy (ANNUAL)

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

Alabama is ranked seventh highest in the United States for obesity (37%) among youth ages 10 to 17. Seventy-six percent (76%) of youth are physically inactive. Data from one survey showed that 20.5% of youth consumed high sugary drinks at least once per day, Nine percent did not regularly consume fruit at all and 10.8% did not regularly consume vegetables.

The Urban Youth STEAM Academy (Science, Technology, Engineering, Agriculture, and Mathematics) is a laboratory-based program that uses tower gardens to encourage youth to eat healthier. The program also includes obstacle courses to increase physical activity and encourages youth interest in the pursuit of STEAM majors and careers.

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

The objectives and outputs were determined based on a statewide grassroots needs assessment, county-based needs surveys, and research-based information. The outputs served as a guide for the Health and Nutrition Specialist to provide training for Extension Agents, who then delivered the content to assigned counties.

Trained Agents helped youth understand the importance of healthy eating and physical activity in reducing risk factors for chronic diseases. There were 31 activities conducted for Urban Youth STEAM Academy. The total number of contacts was 123,909 – indirect (122,855) and direct (1,054).

Four hundred thirty-eight (n=438) youth completed an evaluation. Participants were ages: 5-8 years old, n=114 (26%); 9-12 years old, n=285 (65%); and 13-17 years old, n=39 (9%); By Gender: Female, n=315 (72%) and Male, n=118 (27%); By Race: Black, n=228 (52%), White, n=197 (45%); and By Ethnicity: Hispanic, n=9 (2%) and Non-Hispanic, n=333 (76%).

The results are as follows:

Youth consumed the following food groups, All the Time:

- a) Vegetables, n=127 (29%),
- b) Fruits, n=289 (66%),
- c) Whole Grains, n=250 (57%),
- d) Proteins, n=315 (72%),
- e) Dairy, n=210 (48%)
- f) High Fatty Foods, n=201 (46%) and
- g) High Sugary foods, n=188 (43%).

Reporting youth also stated:

- being physically active all the time, n = 258 (59%) and
- enjoyed the iDance technology, n=272 (62%) .
- The iDance classes were 30-60 minutes, logging 493,233 steps, burning an average of 370 calories.

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

Urban STEAM Academy helped youth to understand the importance of eating fruits and vegetables, reducing the intake of sugar, and being physical activity at least 60 minutes per day.

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

Participation in this program will decrease the risks of obesity and associated chronic diseases in more youth who engage now and as they progress into adulthood. Over time, there is also an opportunity for a reduction in health and medical costs based on long-term program engagement.

Diabetes Empowerment Education Program (DEEP)

Project Director

Paul Brown

Organization

Auburn University

Accession Number

7002237



Diabetes Empowerment Education Program (DEEP) (Annual)

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

Alabama has one of the highest rates of diabetes in the country. Fifteen percent of adults have diabetes, and over 1.3 million have prediabetes. In Alabama, approximately 31,000 new cases are diagnosed annually, with estimated direct and indirect healthcare costs of \$5.4 billion. Diabetes Empowerment Education Program (DEEP) is essential for people with pre-diabetes, diabetes, and care providers to obtain the knowledge and skills necessary to reduce complications resulting from diabetes.

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.

Diabetes Empowerment Education Program (DEEP) participants who completed at least 5 of the six sessions learned about portion control, label reading, choosing carbohydrates wisely, and monitoring their A1C number. The program participants now have knowledge of diabetes risk factors and how to control their glucose levels. After the program, 37.31% of the participants checked their feet compared to only 19.72% in the pre-survey. There was a statistically significant increase in eating more fruits and vegetables with the pre and post-surveys.

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

Thirty-seven million people, or 11.3 of the US population, have diabetes. Of those, 8.5 million people don't know they have it. Approximately 550,149 people in Alabama have been diagnosed with diabetes. An additional 119,000 people in Alabama have diabetes but don't know it, greatly increasing their health risk. Diagnosed diabetes costs an estimated \$5.9 billion in Alabama each year. The serious complications include heart disease, stroke, amputation, end-stage kidney disease, blindness, and death. DEEP addresses these issues with participants and encourages them to share the information with their families and friends. It also decreases healthcare costs for tax-paying individuals.

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

DEEP provides critical information to people affected by diabetes on managing and controlling their diabetes. It provided excellent information that will help anyone to improve and maintain the quality of life for persons with diabetes or persons who have diabetes risk factors. According to the Centers for Disease Control and Prevention, diabetes is our nation's most expensive chronic condition. DEEP can help Alabamians reduce their risk of type 2 diabetes, among those with pre-diabetes, and ultimately prevent or delay serious diabetes complications, saving lives and lowering medical costs.

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.

Escape Vapes: Youth Prevention Program

Project Director

Paul Brown

Organization

Auburn University

Accession Number

7002273



Escape Vapes: Youth Prevention Program (Annual)

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

There has been a staggering increase in middle and high school students using e-cigarettes. Escape Vapes is a program designed to prevent and reduce adolescent use of electronic cigarettes. The program is designed to increase participants' knowledge about nicotine and chemical contents and the health risks of vaping, as well as increase their confidence to abstain from vaping.

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 2022, 2,625 youth participated in Escape Vapes. Of those youth served, 51% were racial/ethnic minorities; 47% were male, 51% were female, and 2% chose not to respond. Seventeen counties were served this year, and programming was done mainly in school-based settings. The program's first goal was to increase youth knowledge that vaping devices contain nicotine, not just flavors or water vapor. 25% of youth who participated in the program increased their knowledge about nicotine content. 46% of youth also had a greater understanding that one pod or disposable vape pen has as much nicotine as one pack of cigarettes. Another goal of the program was to increase knowledge of health impacts. 43% of youth had an increase in knowledge concerning health impacts. We also focused on helping youth understand how vape and e-cigarette manufacturers target young people. Their marketing knowledge increased by 32%. Most importantly, there was a 30% increase in confidence levels in avoiding nicotine products. Overall, there was a statistically significant change across our outcome measures.

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

Escape Vapes seeks to prevent youth vaping use. Underage vaping is a public health issue affecting youth across all socio-economic statuses. Programs that educate youth about the risks of vaping early can reduce the number of youths having to be treated for respiratory issues in clinics and hospitals, especially at a time when COVID, the FLU, and other respiratory issues are concurrently being treated in the same unit. Researchers found that adult e-cigarette users were more likely to report increased hospitalizations, emergency room visits, and physician visits in the last 12 months than non-smokers. The annual cost of this medical use among dedicated e-cigarette users totals \$1.3 billion. This equates to approximately \$1,800 more per e-cigarette user compared to non-tobacco product users. These costs may be higher for teens as they continue to use e-cigarettes into adulthood. Prevention for youth is key to the health of youth in the future.

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

The Human Nutrition Diet and Health regional agents and CECs use an interactive program with adolescents ages 12-18. The program is mainly presented in the school context, including classrooms and assembly/gym settings. Each section and activity in the program is designed to address misconceptions researchers report in their studies about youth. First, we help youth understand that most vaping devices contain nicotine and are addictive. We facilitate this by showing youth how many cigarettes they would have to smoke to equal the amount of nicotine in a vaping device. Second, there is a misconception that vaping devices use water to make vapor. We educate youth by showing them the difference between water vapor and vaping aerosol. Third, youth typically do not think that vaping can impact their health. We show youth how it impacts many parts of their body. Fourth, youth are often unaware that they are being targeted and manipulated by advertisements to get them addicted to nicotine products like e-cigarettes. We show youth the various tactics advertisers have used, and still use, to get

their age group to buy their products. Lastly, confidence to avoid nicotine products is vital to preventing initiation. However, if youth have already started vaping, having developmentally appropriate resources to quit is essential. Escape Vapes teaches youth various ways to avoid vaping and introduces them to youth-focused texting/call quit lines and programs.

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.

Team members presented the Escape Vapes program at the National Extension Association for Family and Consumer Sciences. The presentation was well attended, and we were asked to make the program available in other states. To that end, I have revised the youth prevention program and will seek out ways to extend this program to other Extension programs in the country. Our program was awarded state, regional, and national awards from the Nation Extension Association for Family and Consumer Sciences during this conference.

ALProHealth: CDC High Obesity Program

Project Director

Sondra Parmer

Organization

Auburn University

Accession Number

7002239



ALProHealth: CDC High Obesity Program Annual

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

Alabama has the 2nd highest statewide adult obesity rate at 39.9%, and programming that directly addresses community factors that influence healthy behaviors is essential. ALProHealth aims to reduce obesity rates by investing in community resources that make it easier for residents to practice healthy behaviors.

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 2022, 13 Alabama counties (Barbour, Bullock, Conecuh, Dallas, Escambia, Greene, Lowndes, Macon, Marengo, Monroe, Perry, Sumter, and Wilcox) participated in ALProHealth by developing and maintaining community coalitions, workplans, and associated budgets. The coalitions continuously assessed community needs and identified the most well-suited activities to support the goals of the program based on their community's unique needs. Coalitions increased local access to healthy foods by enhancing two food pantries and one food hub, bringing the total to 25 unique food locations enhanced since 2019. These improvements included additional refrigeration and supplies to assist with curbside food distributions, like folding tables and pop-up tents. Coalitions also addressed physical inactivity in their communities through the development of active transportation action plans that identify opportunities for improving the safety of walking and biking in their communities. These action plans, some of which have been presented to local leadership, addressed 51 total miles of walking and biking infrastructure in three communities, including sidewalks, bicycle lanes, and shared-use paths. A total of nine communities developed plans that addressed 140 total miles since 2020. Lastly, coalitions implemented placemaking projects to create vibrant public spaces, adding unique community resources to help create positive momentum in rural Alabama towns and catalyze additional economic development.

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

Community coalitions led by County Extension Coordinators were the catalysts for change in their communities resulting in places where residents can make healthier choices. By focusing on policy, systems, and environmental changes that can be made at the local level, coalitions were able to create significant changes that made their communities healthier places to live. Additionally, while increasing physical health is the overarching goal of this project, we realize these activities extend into creating places and spaces where people want to live and thrive. Not only did community coalitions address physical health, but activities directly impacted local economic and resource development through the creation of more vibrant communities.

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

Because ALProHealth is a community-wide project, the target audience included all residents within a community where changes were made. However, citizens within the community and the broader public outside of ALProHealth communities also realized benefits from the policy, systems, and environmental changes that inevitably reach beyond a city limit or county line. Obesity is a public health crisis, and the rates of related diseases, such as type 2 diabetes and heart disease, have followed a similar trend. By reducing community obesity rates, other related diseases will be less prevalent, reducing the financial and social impacts poor community health causes.

The Impact of the COVID-19 Pandemic on Housing and Food Insecurity Among Children in Rural Alabama

Project Director

Deden Rukmana

Organization

Alabama A&M University

Accession Number

1024524



The Impact of the COVID-19 Pandemic on Housing and Food Insecurity Among Children in Rural Alabama

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

The central questions of this project are: (1) What is the impact of the COVID-19 pandemic on the access of households with children of rural Alabama to safe and secure housing? (2) What is the impact of the COVID-19 pandemic for households with children of rural Alabama on food security? (2) What strategy do we need to create better housing and food security among children in rural Alabama in response to a pandemic?

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.

- Data of COVID-19 confirmed cases, death, and tests from October 1, 2021 to September 2022 by counties in Alabama have been collected from the Alabama Department of Public Health's Division of Infectious Diseases & Outbreaks.
- Socio-economic data of the population of counties in Alabama from the American Community Surveys 2010, 2015 and 2020 have been collected
- The housing insecurity data by in Alabama including the number of Emergency Rental Assistance (ERA) recipients and other housing insecurity related data by counties are collected from various sources including the Emergency Rental Assistance Alabama, American Community Surveys, and National Low Income Housing Coalition.
- The food insecurity rate for all and children by counties in Alabama in 2019, 2020 and 2021 have been collected from the Feeding America

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

The project is still collecting and analyzing data on housing and food insecurity in rural counties in Alabama.

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

The project is still collecting and analyzing data on housing and food insecurity in rural counties in Alabama.

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

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

A paper from this research project titled "The impact of the COVID-19 pandemic on housing insecurity in rural and urban counties of Alabama" was presented at the 2022 Urban Affairs Association Conference, Washington, DC, April 12-15, 2022.

A paper by Mitchell Edwards titled "The impact of the COVID-19 pandemic on food security in Alabama" is being finalized. He was a graduate research assistant in the project. The paper is also his capstone project (URP 557 - Terminal Research) for the completion of Master of Urban and Regional Planning program at Alabama A&M University

A paper by Aneisha Ingram titled "Racial disparities in housing insecurity during the COVID-19 pandemic in Alabama" is being finalized. She is a research assistant in the project. The paper is also her Senior Project for the completion of Bachelor of Science in Urban and Regional Planning program at Alabama A&M University

Relationship-based Research, Outreach, and Education in Couples with Chronic Illnesses

Project Director

Joshua Novak

Organization

Auburn University

Accession Number

1023159



Relationship-based Research, Outreach, and Education in Couples with Chronic Illnesses

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

The prevalence and rate of chronic disease in Alabama is among the highest and worst in the country. In 2015, an estimated 3.2 million of residents in Alabama have one chronic illness with 1.4 million having two or more chronic conditions, including obesity, cardiovascular disease, diabetes, respiratory conditions, Alzheimer's and dementia, arthritis, cancer, and HIV/AIDS (CDC, 2016). The total estimated direct and indirect costs in Alabama per year is \$45 billion, resulting in a staggering projection of \$671 billion between 2016 and 2030.

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 goals and objectives of this HATCH project are (1) identify and address relational dynamics between individuals with a chronic illness and their partners, (2), improve the health literacy and health behaviors of both partners, and (3) better inform the healthcare practices, interventions, and policies of key stakeholders. My major activities this cycle have resulted in achieve progress in objectives 1 and 3, with several publications (in Appetite, Journal of Health Psychology, Journal of Family Theory and Review, Journal of Social and Personal Relationships, and The Gerontologist) identifying partner and family dynamics related to food and exercise (with current work focusing on sleep at the family-level) as well as biopsychosocial health aging couples. This work has made both theoretical and empirical contributions that underscore the family as the proximal context for both behavior change and illness management. In sum, my recent work has identified both (1) risk and protective factors, (2) conditions under which illness management and health behaviors are successful or not, and (3) the critical and alarming need for dyad and family-level prevention, intervention, and health promotion programs.

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

Although this project is ongoing, results from the project thus far have helped to establish the growing literature base on family-level interventions. Current efforts include targeting funding mechanisms to directly provide services and interventions to people in the state in order to improve health, psychological and relational well-being, quality of life, and longevity. This project has supplied the following products:

Referred Publications:

Novak, J. R., Pratt, K., Hernandez, D. C., & Berge, J. M. (2022). Family Systems and Obesity: A review of key concepts and influences within and between family subsystems and a call for Family-Informed Interventions. Journal of Family Theory & Review. <http://doi.org/10.1111/jftr.12474>

Novak, J. R., August, K., Kavookjian, J., Whitely, H., & Burnett, D. O. (2022). Exploring Typologies of Type 2 Family Members' Illness Appraisals, Involvement, and Psychological Distress. *Journal of Health Psychology*. <http://dx.doi.org/10.1177/13591053221115326>

August, K., **Novak, J. R.**, Peak, T., Gast, J., & Miyairi, M. (2022). Examining Foodwork and Eating Behaviors Between and Among Heterosexual and Gay Couples. *Appetite*. (40% contribution; IF \approx 5.012). <https://doi.org/10.1016/j.appet.2022.105953>

Wilson, S. J., & **Novak, J. R.** (2021). The Implications of Being "in it Together": Relationship Satisfaction and Joint Health Behaviors Predict Better Health and Stronger Concordance between Partners. *Annals of Behavioral Medicine*. <http://dx.doi.org/10.1093/abm/kaab099>

Grants:

2023-2024 A Mixed-Method Approach to Understanding Diabetes Stigma in a Diverse Adolescent Population. Office of Inclusion and Diversity (OID) Exploratory Grants Programs. Whitley, H. ~~P~~, Gamston, C., **Novak, J. R.**, & Kavookjian, J. \$7,000. Submitted 11-03-2022

2023-2028 Comparing a remotely delivered dietary intervention (DASH) vs. DASH with couples relationship education (DASH+CRE) in older married dyads with hypertension. Patient-Centered Outcomes Research Institute. Frugé, A., & **Novak, J. R.** (Dual PIs), Robinson, A.T, Tsai, P.F., and Wang, C.H. (Co-Is). \$3,331,630.79. Submitted 01-10-2023.

Presentations:

Novak, J. R., Frugé, A. D., Wadsworth, D., & Hunt, C. Daily Double Steps: Concordance of Daily Physical Activity between Persons with Type 2 Diabetes and their Partners in the Symposium: Studying naturalistic behaviors and health of individuals and dyads using innovative technologies. American Psychosomatic Society. Puerto Rico, March 2023. Symposium Co-chair.

Novak, J. R. & Monin, J. K. Correlates of Systolic Blood Pressure Recovery in Dementia Care Dyads during a Relationally Stressful Task in the Symposium: Prospective Predictors of Risk of Cardiovascular Disease in Caregivers. American Psychosomatic Society. Puerto Rico, March 2023.

Gossner, J. D., Fauth, E. B., Levin, M., & **Novak, J. R.** Caregiver Depression and Progress Towards Values: An Autoregressive Cross-lagged Panel Model. Poster Abstract for the Gerontological Society of America (GSA) National Conference. November, 2022. Indianapolis, IN.

Piechota, A., **Novak, J. R.**, Vu, T., & Monin, J.K. Emotion regulation and positive affect in spousal dementia care dyads. Positive Affect in Dementia Care Dyads Symposium for Gerontological Society of America (GSA) National Conference. November, 2022. Indianapolis, IN.

Novak, J. R., Whitely, H., Kavookjian, J., & Burnett, D. O. Associations between Diabetes Management and Family Members' Psychosocial and Physical Health during the COVID-19 Pandemic. National Conference for the Association for Diabetes Care and Education. Baltimore, MD. August, 2022.

Novak, J. R., Gunn, H., & Troxel, W. Couples' Sleep Hygiene, Sleep Quality, and Attachment in Opposite-Sex, Bed Sharing Couples. Poster Abstract for the International Association for Relationship Research. July 2022. London, UK.

Mason, M., August, K. J., **Novak, J. R.**, & Markey, C. ~~H~~. Predictors of Collaborative Coping in Couples Managing Type 2 Diabetes: Illness Factors, Relationship. Factors, and Interdependent Self-Construct. Poster Abstract for the International Association for Relationship Research. July 2022. London, UK.

August, K., **Novak, J. R.**, Peak, T., Gast, J., & Miyairi, M. Examining Foodwork and Eating Behaviors Between and Among Heterosexual and Gay Couples. Bidirectional Links Between Family Dynamics and Health Behaviors in Diverse Populations. Symposium abstract for the International Association for Relationship Research. July 2022. London, UK. **Symposium Chair**

Novak, J. R., August, K., Whitely, H., Kavookjian, J., & Burnett, D. O. Exploring Typologies of Type 2 Family Members' Illness Appraisals, Involvement, and Psychological Distress. Bidirectional Links Between Family Dynamics and Health Behaviors in Diverse Populations. Symposium abstract for the International Association for Relationship Research. July 2022. London, UK. **Symposium Chair**

Novak, J. R., Ermer, A., & Wilson, S. J. A Dyadic Latent Profile Analysis of Older Couples' Psychological, Relational, and Physical Health. Where you go, I go: Relationship Dynamics and Dyadic Links to Health and Well-being. Symposium Abstract for the Gerontological Society of America (GSA) National Conference. November, 2021. Phoenix, AZ.

Fauth, E. B., **Novak, J.R.**, Aller, T., Kelley, H., & Levin, M. Higher Value-based Living Attenuates the Link between Frequency of BSPD and Depressive Symptoms through Lower Caregiver Burden in Family Dementia Caregivers. Poster Abstract for the Gerontological Society of America (GSA) National Conference. November, 2021. Phoenix, AZ.

Novak, J.R., Wei, M., & Seaton, K. Associations between Health Support and Control and Exercising Together on Exercise Self-Efficacy in Heterosexual Married Couples. Poster Abstract for the National Council on Family Relationships. National Conference. November, 2021. Baltimore, MD.

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

My project activities have benefit the broader public by informing ways in which resources can be saved, pooled, or better appropriated to interventions that target multiple family members at the same time and thus reducing healthcare utilization and taxpayer burden in society overall.

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

No major problems have occurred with the exception of moving to another office building that have raised new challenges and slowed down my efforts. Alas those should be behind me in the coming months and I will be ready to grow and expand my efforts.

However, my work and project have furthered my interdisciplinary nature of my work by (1) reviewing for other discipline journals, including Journal of Diabetes Research, International Journal of Behavioral Medicine, and Sleep Health, (2) spreading my dissemination to other fields, including presenting my work at American Psychosomatic Society, American Psychological Society, the National Sleep Foundation's annual conference. Additionally, as PI, I recently submitted 1 major external funding proposal that will directly target, recruit, and enroll patients and their partners with hypertension in a dietary and relationship intervention program. In addition, other funds have been acquired to further recruit and expand a longitudinal project with Alabamian couples with chronic illnesses.

Secular Trends in the Association between Childhood Circumstances and Adult Health: An Examination of Mechanisms Using Two Nationally Representative Samples

Project Director

Thomas Fuller-Rowell

Organization

Auburn University

Accession Number

1021450



Secular Trends in the Association between Childhood Circumstances and Adult Health: An Examination of Mechanisms Using Two Nationally Representative Samples

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

The link between childhood socioeconomic status (SES) and adult health can be conceptualized as a social indicator capturing levels of health stratification or health opportunity. Despite the nearly self-evident social and scientific significance of health stratification indicators, historic time trends in the strength of the associations between childhood SES and adult health are not well understood. Furthermore, although an emerging literature provides evidence of a secular trend in the association between adult SES and adult health, changes in the pathways by which childhood circumstances influence adult health--and their moderating influences at the societal, community, and individual levels--remain to be illuminated.

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

As socioeconomic inequalities have risen in recent decades society has become more divided. One possible consequence of these divisions is increased unfair treatment and discrimination directed towards less advantaged groups. Published findings from our research with a national sample of adults in the United States showed that socioeconomic status has become more strongly associated with experiences of discrimination in recent years. These results suggest that social class discrimination is on the rise. This finding has implications for the link between childhood socioeconomic disadvantage and adult health outcomes because social class discrimination is one important potential mechanism for this link.

Findings from a second published study based on our own data collection with a cohort of young adults in the Southeastern region of the United States also suggest a trend towards increases in the prevalence of discrimination. Specifically results showed increases in discrimination between 2019 and 2020, particularly among Black/African American young adults. Results of this study suggest that discrimination directed towards racial/ethnic minority groups may have been adversely impacted by the pandemic. In other published results from this cohort study, we have also shown increases in depressive symptoms, physical symptoms, and sleep-wake problems from before to during the COVID-19 pandemic among young adults.

A third published study examined the link between neighborhood disadvantage in childhood and blood pressure among young adults. Results of this study showed that neighborhood disadvantage in early childhood was linked to blood pressure in young adulthood and explained a portion of the Black-White racial disparity in blood pressure. Taken together with established research showing that neighborhoods have become more segregated by socioeconomic status in recent decades, these results suggest that childhood neighborhood contexts are an important potential mechanism for the strengthening association between childhood disadvantage and adult health.

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

Our target audience includes academic, public health, policy, and community audiences with an interest in population health and health disparities. Our published findings help to extend scientific knowledge in our areas of research. The following four manuscripts were published to disseminate results:

1. Jokela, M. & **Fuller-Rowell, T. E.** (2022). Changing associations between socioeconomic status and self-reported discrimination from the 1990s to the 2010s in the United States. *International Journal of Psychology*. DOI: [10.1002/ijop.12853](https://doi.org/10.1002/ijop.12853)
2. **Fuller-Rowell, T. E.**, *Nichols, O. I., El-Sheikh, M., Burrow, A. L., Ong, A. D., & Ryff, C. D. (2022). The pandemic and social experience: For whom did discrimination and social isolation increase? *Cultural Diversity and Ethnic Minority Psychology*. DOI: [10.1037/cdp0000561](https://doi.org/10.1037/cdp0000561)
3. Nichols, O. I., **Fuller-Rowell, T. E.**, Robinson, A., Eugene, D., & *Homandberg, L. (2022). Neighborhood Deprivation in Early Childhood Contributes to Racial Disparities in Blood Pressure in Young Adults. *Journal of Youth and Adolescence*. DOI: [10.1007/s10964-022-01658-6](https://doi.org/10.1007/s10964-022-01658-6)
4. **Fuller-Rowell, T. E.**, *Nichols, O. I., Doan, S. N., Adler-Baeder, F., & El-Sheikh, M. (2021). Changes in depressive symptoms, physical symptoms, and sleep-wake problems from before to during the COVID-19 pandemic among emerging adults: Inequalities by gender, socioeconomic position, and race. *Emerging Adulthood, 9 (COVID-19 Special Issue)*, 492-505. DOI: [10.1177/21676968211042111](https://doi.org/10.1177/21676968211042111)

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

The broader public may benefit from evidence informed policies that can be improved by scientific consensus in our areas of research.

Obesity-linked Non-alcoholic Fatty Liver Disease Progression and Colorectal Cancer

Project Director

Michael Greene

Organization



Obesity-linked Colorectal Cancer

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

Both obesity and colorectal cancer (CRC) are major public health concerns that affect morbidity and mortality in the United States but also worldwide. Our long-term goal is to delineate the mechanism(s) by which obesity (included liver and adipose tissue inflammation) is linked to CRC progression. We are currently working on new models of obesity and CRC to establish physiologically-relevant platforms to identify new therapeutic targets and screen for drugs to treat CRC.

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 project team which includes the laboratory of Dr. Elizabeth Lipke has been focused on the development of physiologically-relevant *in vitro* models of CRC using patient-derived xenograft (PDX) established from patient colon tumors. We have also been refining an *in vitro* adipose tissue model for use in a co-culture system to examine the obesity-CRC link. Our significant progress includes the following findings:

1. Cells from CRC colon cancer PDX tumors can be successfully encapsulated in a biomimetic, hydrogel material, PEG-fibrinogen to form 3-dimensional (3D) engineered cancer tissues, and those tissues can be maintained *in vitro* in long-term culture (29 days).
2. Using three PDX lines established from Stage II, IIIb, and IV colon cancer tumors, our results demonstrate a strong correlation between our *in vitro* 3D engineered cancer tissues and the originating *in vivo* PDX tumors, providing evidence that these engineered tissues may be capable of mimicking patient- and/or cancer stage-specific heterogeneity.
3. We preformed a transcriptomic analysis to elucidate links between the distinct CRC consensus molecular subtypes and obesity to better understand the pathophysiology of CRC. Our findings suggests that obesity is linked to CRC through consensus molecular subtype-dependent pathways.
4. We have refined an adipose tissue inflammation *in vitro* model of obesity by modulating the treatment time with recombinant TNF alpha and hypoxia in 3T3-L1 differentiated adipocytes to generate inflamed adipocytes that maintain cell viability and an inflammatory phenotype. Importantly, the inflamed adipocytes do not carry over recombinant TNF alpha that could directly effect co-cultured 3D engineered cancer tissues.

A significant achievement for the obesity-CRC project team in the past year was being awarded a 5-year NIH R01 grant. The grant award details are as follows:

Title: Engineered Colon Cancer Tissue to Examine the Impact of the Obese Microenvironment

Agency: National Institutes of Health (NIH)

Funding Mechanism: R01

Project Director: Elizabeth Lipke, Ph.D./Michael Greene, Ph.D.

Funding Period: July 2022 –June 2027; Award: \$ 2,496,423

Role: co- Principal Investigator

Score: 7th Percentile (pay line was 11th Percentile)

Award Number: 1R01CA267170-01A1

The following manuscripts were published in 2022:

1. Luo, Y., Woodie, L.N., Graff, E.C., Zhang, J., Fowler, S., Wang, X., Wang, X., O'Neill, A.M., and Greene, M.W. (2022) Role of liquid sugar in regulating the hepatic transcriptome in a high-fat Western diet model of NAFLD. *J. Nutr. Biochem.* Oct 21:109174. doi: 10.1016/j.jnutbio.2022.109174

Impact Factor: 6.117 (#23 out of 90 in Nutrition & Dietetics by Eigenfactor Score)

2. Greene, M.W., Abraham, P.T., Kuhlers, P. C., Likpe, E. A., Heslin, M. J., Wijaya, S. T., and Odeniyi, I. (2022) Consensus molecular subtype differences linking colon adenocarcinoma and obesity revealed by a cohort transcriptomic analysis. *PLOS One* 17(5):e0268436 <https://doi.org/10.1371/journal.pone.0268436>

Impact Factor: 3.752 (#5 out of 73 in Multidisciplinary Sciences by Eigenfactor Score)

3. Carroll, K.L., Frugé, A.D., Heslin, M.J., Lipke, E.A., and Greene, M.W. (2022) Diet as a Risk Factor for Early-Onset Colorectal Adenoma and Carcinoma: A Systematic Review. *Frontiers in Nutrition* Volume 2022;9. doi: 10.3389/fnut.2022.896330.

Impact Factor: 6.590 (#27 out of 90 in Nutrition & Dietetics by Eigenfactor Score)

4. Hassani, I., Anbiah, B., Kuhlers, P., Habbitt, N.L., Ahmed, B. Martin J Heslin, M.J., Mobley, J.A., Greene, M.W.*, and Lipke, E.A.* (2022) Engineered Colorectal Cancer Tissue Recapitulates Key Attributes of a Patient-derived Xenograft Tumor Line. *Biofabrication* <https://doi.org/10.1088/1758-5090/ac73b>

*Co-corresponding authors

Impact Factor: 10.020 (#19 out of 90 in Engineering, Biomedical by Eigenfactor Score)

5. Riviere, A. J., Smith, K. S., Schaberg, M. N., Greene, M. W., and Frugé, A. D. (2022) Plasma and fecal zonulin are not altered by a high green leafy vegetable dietary intervention: secondary analysis of a randomized control crossover trial. *BMC Gastroenterol* 22, 184 (2022). <https://doi.org/10.1186/s12876-022-02248-3>

Impact Factor: 3.067 (#38 out of 93 in Gastroenterology & Hepatology by Eigenfactor Score)

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

Our key target audience is fellow scientists in field of metabolic diseases and cancer which has been reached through our journal publications and scientific meeting presentations. Our findings will assist others in the field working with 3D engineered cancer tissues. Our findings that obesity is linked to CRC in a consensus molecular subtype is novel, and my spur new avenues of investigation into the obesity-CRC link.

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

There is a critical need for new cancer models to identify new therapeutic targets and screen for drugs to treat CRC. Our project activities have the potential to develop a new cancer model platform which could benefit potentially millions of people (1.9 million incident cases and 0.9 million deaths worldwide due to CRC).

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.

Some of hurdles encountered last year have been passed. With the NIH R01 funding, Dr. Lipke and I are now part of the National Cancer Institute Tissue Engineering Collaborative which will provide new opportunities for training and professional development for our students and post doctoral fellows.

Project Director

Francesca Adler-Baeder

Organization

Auburn University

Accession Number

1017587



Promoting Relational Health Among Limited Resource Parents

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

Alabama citizens, particularly low-resource individuals and families have a long history of relational instability. Relationship health affects all other dimensions of health. This project is focused on investigating the effectiveness of Couple/Relationship Education programs for limited resource, ethnically diverse parents. Using a systems perspective that assumes benefits in multiple areas, improvements are assessed in individual well-being, couple functioning, coparenting functioning, parenting, and child outcomes. Also considered are influences on program effectiveness. We investigate whether participant and program characteristics explain variations in the levels of change and benefits that occur following participation. This project is also investigating the effects of program design and content by comparing the benefits of alternate forms of the program in which program content varies (i.e., CRE only; CRE + stress management/mindfulness training). In 2020, a focus on youth relationship education and its effectiveness was added.

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

1. We successfully implemented relationship education programming in multiple counties exceeding our target number for enrollment for low-income couples and for youth. We exceeded our enrollment target for youth for the 2021-2022 year: 2568/2200 (117%) in our youth relationship education workshop series; and exceeded enrolled goals for couples: 599/565; 106% of enrollment target.
2. We met our program completion target for both projects: 451/450 couples (101%) and 2020/1650 youth participants (122% of goal). Completed the program.
3. Retention was high for youth participants: 95% (2,428/2,568) of program enrollees attended 50% or more of workshop session series hours and 2020 completed 90% the program (122% of our goal for completed participants for the year 2020/1650).
4. Retention was high for couples: 75% of enrolled couples attended 100% or more of primary workshop hours and 80% attended 50% or more of primary workshop hours.
5. A high percentage of program participants completed baseline and follow-up surveys.
6. We implemented 135 workshop session series for youth during this project year with an average of 17 youth in each session.
7. We offered 52 workshop session series for couples, with an average of 10 adult couples participating in each session.

8. We reached our target population of diverse couples and youth: we served a racially diverse (46% Black or African-American; 48% White; 6% other races) and primarily low-income population (45% reporting less than \$2,000 income in the last 30 days).

For youth enrolled during this reporting period, demographic characteristics reveal that we are serving a racially diverse population (51% White; 45% Black or African-American; 4% other/mixed ethnicity). Further, 54% of youth identified as female, 44% as male, and 2% as non-binary or transgender.

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

The key publication from the 2015-2020 efficacy study was published in 2022, along with several other papers on related findings. We documented a successful efficacy trial for low income couples. Using multilevel growth modeling, results revealed a statistically significant ($p < .05$) difference in average growth over one year between program participants in the two curricula tested (ELEVATE and Couples Connecting Mindfully [CCM]) and the control group in each of the 3 domains of functioning (individual, couple, and family) indicated program impact for couple relationship education.

Specifically, ELEVATE participants' average rate of change was significantly different from the control group's rate on 5 of the 6 measures assessed. ELEVATE participants reported significant improvements over 1 year in couple relationship skills, mental health, sleep quality, couple well-being, and family harmony compared to the control group, who did not change or declined (as was the case for couple well-being). ELEVATE participants and control group did not differ in the average rate of change over one year in physical health.

For CCM participants, the average rate of change was significantly different from the control group on 3 of the 6 measures assessed. CCM participants reported significant improvements over 1 year in couple relationship skills, couple well-being, and family harmony compared to the control group who did not change or declined (as was the case for couple well-being). CCM participants and control group did not differ in the average rate of change over one year in mental health, sleep quality, or physical health.

The program effects were also documented up to the 2-year follow-up mark and that different profiles of participants experienced differential patterns of change over the 2 year period, using mixture modeling procedures. Publications on these results are in process.

Using path analyses, results also supported the hypothesis related to spillover of improved couple skills targeted in the program and couple satisfaction at 6 months post-program: For ELEVATE participants greater immediate improvements in couple relationship skills after ELEVATE participation predicted greater improvements in couple satisfaction at 6 months ($\beta = .250, p < .001$). For CCM participants greater immediate improvements in couple relationship skills after CCM participation predicted greater improvements in couple satisfaction at 6 months ($\beta = .205, p < .001$).

2022 was the launch of the impact study of two new related projects funded by the US Dept of Health and Human Service, following the start-up period for the two new efficacy studies of relationship education for couples and relationship education for youth in high schools. (Funding is \$12.5 million for 2020-2025).

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

The Alabama citizens who have participated in the program have benefitted in their knowledge and skills that promote relational health. The dissemination of our experiences and findings also benefit the broader public since the programs are available and can be implemented in other communities around the country.

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

No major changes or problems encountered. Staff assigned to the project have participated in training in advanced methods, cultural sensitivity in community programming, best practices in facilitation skills, domestic violence and child abuse awareness. Further, they have participated in a minimum of 1 national research conference on family science annually. All faculty, staff, and students participated in comprehensive training updates in evidence-based curricula, including *Relationship Smarts Plus*, *Mind Matters*, *Money Habitudes*, and *ELEVATE*.

To date, activities have been reported to the federal sponsor through quarterly reporting. Dissemination of project activities and related research were also shared through peer-reviewed publications and research conference presentations.

Publications:

Journal Articles:

1. Garrison, C., Neeley, D., McGill, J., & Adler-Baeder, F. (in press). Social influences predicting involvement in couple relationship education and marital quality. *Family Relations*
2. McGill, J., Adler-Baeder, F., & Burke, L. (2022). The Mindfulness in Couple Relationships Scale: Development and Validation. *Mindfulness*.
3. Jackson, T.*, Adler-Baeder, F., Burke, L., & Vilches, S. (2022). Evaluating a relationship education program with incarcerated adults. *Journal of Human Sciences and Extension*. 10(1)
4. Adler-Baeder, F., Futris, T., McGill, J., Richardson, E., & Dede Yildirim, E. (2022). Development and validation of the Couple Relationship Skills Inventory. *Family Relations*. 71:279–306. <https://doi.org/10.1111/fare.12590>
5. Adler-Baeder, F. McGill, J., Yildirim, E.D., Gregson, K., Cooper, E., Burke, L., Finnegan, V., & Jackel, R. (2022). Simultaneous Randomized Control Trials of the One-Year Efficacy of Two Couple Relationship Education Programs: ELEVATE and Couples Connecting Mindfully. *Family Process*. DOI: 10.1111/famp.12750

Book chapters:

Adler-Baeder, F. & Gregson, K. (2022). Couple Instability. In B. van-Eeden- Morefield & S. Browning (Eds.). *Treating Interpersonal Problems in Contemporary Families: An Inclusive Approach to Engaging Evidence Supported Practice*. American Psychological Association.

Higginbotham, B. & Adler-Baeder, F. (2022). Stepfamily education. In Hartenstein, J. L. (Ed). *Marriage and Divorce in America*. Santa Barbara, CA: ABC-CLIO.

This year concludes the project term for NIFA.

Childhood Obesity in Alabama: Risk Factors

Project Director

Geetha Thangiah

Organization

Auburn University

Accession Number

1017405



Childhood Obesity in Alabama: Risk Factors

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

The objective of this proposal is to delineate the multiple factors that are contributory to the increased prevalence of childhood obesity in Alabama. This project addresses the significant gaps in understanding the bio-behavioral factors that include lifestyle habits, dietary habits, environmental, biological factors, genetic, and microbial profile that cause an increase in childhood obesity.

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

We determined the association of salivary fetuin-A, insulin, and adiponectin with obesity measures in children. Salivary fetuin-A and insulin were significantly increased, and adiponectin was decreased in obese compared to normal weight. Fetuin-A and insulin positively correlated with obesity measures, while adiponectin was inversely associated. We also evaluated the salivary BDNF and β -NGF and their association with anthropometric measurement, blood pressure, and salivary insulin in children. The salivary concentration of BDNF and NGF was higher in obese children and is positively associated with anthropometric measures, suggesting that neurotrophins can be used as a non-invasive predictor of obesity-related complications in children. In addition, we analyzed the 11q11 gene copy number variance (CNV) based on gender in White/European American and African American normal weight and overweight/obese children. The normal weight and

overweight/obese girls were significantly less likely to belong to the low copy number variant group of 11q11 compared to boys; similarly, normal weight and overweight/obese African American children were significantly less likely to belong to the low copy number variant group. The African American girls in the low copy number variant had significantly higher BMI z-scores. Our findings suggest that the 11q11 copy number in children is race and gender-specific.

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

The target audience includes undergraduate students, graduate students, faculty, research scientists, and physicians. They benefit from the findings published in peer-reviewed manuscripts and presented at conferences and meetings.

Peer-reviewed manuscripts:

1. Selvaraju V, Babu JR, **Geetha T**. Salivary neurotrophins brain-derived neurotrophic factor and nerve growth factor associated with childhood obesity: A multiplex magnetic luminescence analysis. *Diagnostics* 2022; 12(5):1130. doi: 10.3390/diagnostics12051130 Highlighted in cover page <https://www.mdpi.com/2075-4418/12/5>
2. Selvaraju V, Babu JR, **Geetha T**. Multiplexed measurements of salivary fetuin-A, insulin, and adiponectin as potential non-invasive biomarkers in childhood obesity. *Cytokine* 2022; 153:155843. doi: 10.1016/j.cyto.2022.
3. Patel P, Babu JR, Wang X, **Geetha T**. Role of macronutrient intake in the epigenetics of obesity. *Biochemical Society Transactions* 2022; BST20211069. doi: 10.1042/BST20211069.
4. Phillips M, Selvaraju V, Fouty A, Babu JR, Sandey M, **Geetha T**. High olfactory receptor-rich 11q11 copy number in girls and African American children. *Genes* 2021; 12 (12):1943. doi: 10.3390/genes12121943.

Presentations at meetings:

1. 1. 1. Patel P, Selvaraju V, Wang X, Babu JR, **Geetha T** (2022). Racial variability in methylation of NRF1 and FTO gene in childhood obesity. “2022 Auburn Research Student Symposium”, Auburn University, Auburn, AL, USA, March 28, 2022 (oral presentation).
2. Chester B, Selvaraju V, Cassie A, Sydney B, Martin K, **Geetha T** (2022). Hemoglobin A1c Level and the Efficacy of a Diabetes Self-Management Education and Support Coaching Structure for the Ongoing Management of Type 2 Diabetes. “2022 Auburn Research Student Symposium”, Auburn University, Auburn, AL, USA, March 28, 2022 (oral presentation).
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Briefly describe how the broader public benefited from your project's activities.

An article on “Childhood Obesity” was published in Opelika Auburn news, local today news, Dothan eagle news, and postuszero news. The research project findings from my group were written in the article. This will help the community to receive awareness about the complexity of childhood obesity and the multiple factors that can be related to obesity.

Critical Issue

Natural Resource and Environmental Sustainability

Chickens and Rabbits: Two Contrasting Animal Models to Study Appetite

Project Director

Jorge Vizcarra

Organization

Alabama A&M University

Accession Number

7000731



The effect of Na Octanoate doses on ghrelin concentrations in chickens and rabbits

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

Ghrelin is a key hormone involved in feed intake with a differential contribution in mammalian (rabbits) and non-mammalian (chickens) species. Dietary fatty acids can be used as substrates for ghrelin's acetylation process to change the ratio of acetylated (active ghrelin) to non-acetylated ghrelin (non-active ghrelin). Therefore, changes in the diet may provide a unique opportunity to regulate ghrelin's activity and could eventually become an alternative to the skip-a-day feeding in the poultry industry or as an appetite enhancer in rabbits and other mammalian species.

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

We rationalize that ghrelin is a key hormone involved in feed intake with a differential contribution in rabbits and chickens. Our goal is to determine the contribution of ghrelin in the endocrine control of appetite in mammalian and non-mammalian species.

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

Treatments that can **decrease appetite** at critical periods of production (without affecting animal wellbeing) can provide new tools with commercial implications that will result in a direct benefit for the poultry industry.

Treatments that can **increase appetite** in rabbits, by regulation ghrelin secretion, can provide new tools with direct benefit to rabbits and other mammalian species.

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

The control of appetite is of primordial importance in both mammalian and non-mammalian species

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

No major changes have been encountered.

Several undergraduate students and one graduate student have been involved in the project.

The Master Environmental Education (MEE) Program

Project Director

Amelia Mitchell

Organization

Auburn University

Accession Number

7004612



The Master Environmental Education Program

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

Baldwin county is a unique part of Alabama adjacent to the Gulf of Mexico and host to millions of tourists each year. It continues to increase in population with Foley, Fairhope, Gulf Shores, and Spanish Fort being the fastest growing cities. Baldwin County is the fastest growing county in Alabama and 7th fastest growing metropolitan area in the United States. Population growth brings increased pressure on the environment: many new homes are built; septic systems are installed; more water is used; and more waste is thrown out. All these activities affect our watershed. The Master Environmental Education Program plays an important role in instilling natural resources knowledge that will help our environment be sustainable for years to come.

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 Master Environmental Education Program assists the youth in understanding appreciation for the environment in their own backyards. They understand that actions they make now will affect everything from the air they breathe to the water they drink. Such as picking up trash in their school yard, talking to their parents about reading labels before they fertilize the yard, starting a recycling program in their homes, conserving energy and water, and proper ways to dispose of household products, etc. We want to instill the value of preserving the environment in order to benefit themselves and future generations.

Goals & Objectives:

- Encourage Baldwin County residents to become good environmental stewards.
- Educate our residents to protect our coastal environment.
- Promote the value of our environment to our residents.
- Provide opportunities for youth and adults to enjoy the outdoors.

MEE Impacts:

- 77% responded they will pick up a piece of litter when you see it at school.
- 100% responded they can identify at least one of the invasive plants.
- 73% responded they will encourage your parents to read product label directions for fertilizer and pesticides.
- 90% responded they will find a way to conserve energy at home.
- 100% responded they can name the four stages of the water cycle.
- 66% responded they will you ask your parents to consider leaving water out for backyard wildlife

The Master Environmental Education Program volunteers and ACES Staff have presented 3,114 sessions to over 96,808 youth in Baldwin County schools over the last 27 years. A total of 5,988 volunteer hours were used to teach the MEE Program to Baldwin County Students. Note that some statistics were not generated in earlier years of the program.

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

Students have a greater understanding of environmental stewardship and the importance of protecting our coastal environment as it pertains to Baldwin County. Our program allows the students to explore environmental issues, engage in problem solving, and take actions to improve the environment. As a result, they develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions as they grow to adulthood as well as discuss these issues with their parents.

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

Baldwin County is the largest county in Alabama. It is 97 miles long and 43 miles wide. The county consists of beaches, wetlands, delta, forests, and farmlands. Approximately 25% of the population lives within a few miles of wetlands. The entire population, which lives in two major watersheds, obtains most of its drinking water from groundwater. Our program inspires students to research, enquire about how and why specific things happen, and later make their own decisions about complex environmental issues. By strengthening critical and creative thinking skills, environmental education enables the children to evaluate the circumstances that are affecting the environment. Instilling the value of preserving the environment benefits future generations to come.

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 Master Environmental Education (MEE) Program was developed in 1995 so Baldwin County residents would understand and appreciate the environment in their own backyards. The Alabama Cooperative Extension System/Baldwin County Office created the curriculum guide from various environmental research-based sources. Our lessons include: Groundwater, Pollution, Invasive Plant Species, Backyard Wildlife Habitat, Aquatic Nuisance Species, Energy, Stormwater Pollution, Recycling, the Water Cycle and Alabama Water Watch. The 9 lessons are taught by trained MEE Volunteers and Baldwin County Extension staff. We have volunteers from a wide range of backgrounds and experience. These include professionals on the job, retirees, and those that are passionate about our environment.

Each 45-minute lesson plan correlates to the Alabama Course of Study for Science and includes a PowerPoint with various visual aids and activities. Baldwin County teachers schedule a lesson plan with the Baldwin County Extension office by email, phone or our MEE website. The Extension office then schedules a MEE volunteer to pick up a teaching kit and teach that particular lesson. We maintain 4 different locations to house our teaching kits

Our MEE volunteers attend at least two training workshop each year and receive up-to date lesson plans to encourage 2nd – 12 graders in environmental stewardship. They learn teaching techniques (including the use of teaching models and tips for responding to questions) and use the researched based information provided to help students learn about the environment.

The MEE program continues each year to make a difference in training volunteers and teaching children these important environmental issues. Students participate in the program each year at Baldwin County Schools.

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.

[Wiregrass Farm Safety and Grain Bin Simulator Rescue](#)

Project Director

Amelia Mitchell

Organization

Auburn University

Accession Number

7004613



Wiregrass Farm Safety and Grain Bin Simulator Rescue

Final Result

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

The 2019 data for the U.S. Bureau of Labor Statistics indicates that the agricultural sector is the most dangerous in America with 573 fatalities, or an equivalent of 23.1 deaths per 100,000 workers. Farmers work around large equipment, chemicals, and other dangerous scenarios like extreme heat every day. It is important that first responders are familiar with the conditions farmers work in so when a call is sent out to a farm accident they can properly respond.

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 project was broken down into two phases. The Alabama Cooperative Extension System in conjunction with Wiregrass RC&D hosted two farm safety events during the summer of 2021. The first event was a farm equipment extrication exercise held June 26 and the second was a grain bin entrapment training held September 21. Both events were held at the Wiregrass Research Station in Headland. The first phase was a farm safety training for first responders. Using the resources at the Wiregrass Research Center and connect with Wiregrass CEC we were able to host a successful training for city and volunteer fire departments. In phase, two we partnered with Mississippi Farm Bureau and Wiregrass RC&D for a grain bin simulator training at the Wiregrass Research Center.

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

Over 30 firefighters from across the Wiregrass region met to learn how to respond to an accident involving farm equipment. The Dothan and Headland Fire Departments setup two lifelike scenarios, a tractor tire roll over and auger/PTO entanglement. 53 first responders received credit for the grain bin rescue training. The Alabama Fire College provided credit hours for both events. As a result of these programs, Wiregrass first responders are better equipped for on farm emergencies. Many purchased their own grain bin extraction tube and requested follow up training for their departments.

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

Just after the farm safety training, one of the departments that attended had a call about a tractor roll over. They were able to take what they learned from the training we provided and use it at a real-life scenario. First responders having training in heavy equipment extraction helps the general public by raising awareness of on farm dangers and having local departments that are prepared with the right tools to respond.

Extension Master Gardener Volunteer Training & Management

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7004557



Extension Master Gardener Volunteer Training & Management - Annual

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

County Extension offices report that Home Grounds topics remain dominant from clients' calls, asking questions and wanting programs. Trained, Extension volunteers help meet this demand and expand the outreach capacity of the Home Grounds team. The goal is to recruit, train, and retain a core group of volunteers interested to support Extension Home Grounds programs, and expand this outreach with volunteer led programming.

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.

Home Grounds Agents provided hybrid training for MG Interns, with support and leadership from Emily Bornstein, Vol. Training Coordinator. We offered training in 28 counties and trained 380 MG Interns from 43 counties (increase over 2021, 11 more counties and 54 more Interns). Ongoing Agent engagement supported EMGV's to worked in 12 Helpline offices and maintain 20 Demonstration/teaching gardens (used by Agents and EMGV's for programs). EMGVs also contributed to Extension programs as speakers and facilitators, hosted Lunch&Learns and other public education activities, managed/mentored community food gardens, grew and donated produce, donate time and materials to public parks and gardens, supported Farm City, Arbor Day, County Fairs and other local events, supported medical research (Harvest for Health), and other local priorities in their communities.

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

1. Agents recruited and trained 380 Intern EMGVs to join the team. The total knowledge gain for this group was 43%. 2. Agent training and support gave EMGV's confidence and knowledge to work 12 Helpline offices and lead Ask-A-MG booths. 3. EMGVs were successful in their efforts to create and maintain 20 demonstration/teaching gardens. 4. Agent/EMGV relationships led to an average time donation of 87 hours/EMGV. 5. EMGV support increased by 8%, with 1,472 reporting hours in 2021 and 1,590 reporting in 2022. 6. With support and instruction from Agents, EMGV's grew and donated more produce in 2022 (17% increase over 2021 donations). 7. Since 2010, Agents have recruited, trained and supported over 500 EMGVs in contribution to medical research, Harvest for Health (partnership with UAB O'Neal Cancer Center). This gave each volunteer confidence and knowledge to successfully mentor cancer survivors through 12 months of vegetable gardening. This research study ends February 28, 2023.

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

The broader audience served by this program, is the general gardening public, using a teamwork approach of Extension volunteers and Agents in program delivery. 1. Through Helplines and Ask-A-MG booths, EMGV's answered 168,600 home garden questions. 2. Demonstration/teaching gardens reached 502,000 with home garden instruction. 3. Grow More, Give More. EMGV's grew and donated 16.5 Tons of fresh produce to local food charities. Donations came from their personal gardens, community gardens they mentored, and their demonstration gardens. 4. Harvest for Health. From preliminary data analysis, we estimate that 80% of the cancer survivors (513 research participants) are still gardening. Gardening also helped participants improve their physical health and diet. Final data analysis is expected in fall 2023. 5. Total community value of EMG Volunteers in 2022 = \$9.4 M (donated hours, produce, plants/materials, and philanthropy).

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.

Note-1. The Master Gardener Program supports two "critical issues", Natural Resource Conservation and Global Food Security. Note-2. Volunteers work for the benefit of relationships, not a paycheck. Volunteers are motivated by personal connections. Building and maintaining these relationships requires extra time from Extension personnel. Agents can educate anyone, but recruiting and retaining volunteers requires personal investments from the ACES Agents who lead this ACES program.

Integrating Nanotechnology and Stable Isotope Techniques to Address Issues and Challenges at the Critical Agriculture-Water-Environment Nexus (AWEN) in Alabama

Project Director
Dengjun Wang
Organization
Auburn University
Accession Number
1026347



Enhancing agricultural productivity by nano-enabled agrochemicals

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

Conventional agrochemicals such as pesticides (and fertilizers) are facing increasing challenges due to their low use efficiency and high environmental hazards. Under this hatch project, we find that nano-enabled agrochemicals of nano-pesticides have significantly higher use efficiency with minimized potential risks to the environment. These nano-enabled agrochemicals are well positioned to significantly enhance agricultural productivity for sustainable agriculture in the very near future.

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

We conducted a comprehensive analysis of the key properties of nano-pesticides in controlling agricultural pests for crop enhancement compared with conventional pesticides. Our analyses showed that when compared with conventional pesticides, the overall efficacy of nano-pesticides against target organisms was 31.5% higher, including an 18.9% increased efficacy in field trials. Notably, the toxicity of nanopesticides toward non-target organisms was 43.1% lower, highlighting a

decrease in collateral damage to the environment. The premature loss of active ingredients prior to reaching target organisms was reduced by 41.4%, paired with a 22.1% lower leaching potential of in soils. Nano-pesticides also render other benefits, including enhanced foliar adhesion, improved crop yield and quality, and a responsive nanoscale delivery platform of active ingredients to mitigate various pressing biotic and abiotic stresses (for example, heat, drought and salinity). These benefits, if harnessed appropriately, can promote higher crop yields and thus contribute towards sustainable agriculture and global food security.

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

Regulatory agencies, particularly including the U.S. Environmental Protection Agency (EPA) for pesticide regulation will find this information very critical with respect to issuing nanopesticide related patents to vendors in the future. The project findings will also be very useful for the Integrated Pest Management by the USDA. Additionally, farmers will find that using nanopesticides instead of conventional pesticides will not only likely enhance crop yields, but also minimize potential environmental risks.

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

Public perception and consumer acceptance ultimately determine the success or failure of nano-enabled food products. Safety concerns surrounding nanopesticide-produced food closely link government regulators, policymakers, farmers, consumers and other stakeholders. A multi-agency effort is needed to coordinate and address food safety concerns associated with nanopesticide applications. Our project findings will significantly expand the public knowledge and understanding of the food safety associated with nano-enabled agrochemicals, which will be on the market in the very near future.

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

No.

Understanding the biological aspects for strategically managing important household and structural pests in Alabama

Project Director
Xing Ping Hu
Organization
Auburn University



Understanding the biological aspects for strategically managing important household and structural pests in Alabama

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

Household and structural insect pests harm humans and pets, cause diseases, damage homes and properties, and affect the living environment. Housing pest infestations are increasing, due to continuing global climate change and urbanization expanding, and so is the need for pest control technologies that protect the health and property of citizens, urban ecosystems, and wildlife with the optimal and most minor use of toxic pesticides in and around homes. However, inadequate knowledge of pest biological traits and pest-environment interactions has limited the development of more effective and sustainable pest control technologies.

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 project aims to fill some critical knowledge gaps to address issues of concern to industry manufacturers, pest control professionals, and property owners through empirical investigations. Additionally, laboratory and field experiments will be conducted to evaluate the effectiveness and efficacy of various pest control products and technologies targeting termites, cockroaches, ants, and emerging invasive pest species. Results from this project gain new knowledge on the biology, behavior, physiology, and ecology of urban arthropod pests that live in and around our homes and aid in developing and implementing safe, biologically based, cost-effective, and sustainable integrated pest management (IPM) systems for the control of urban arthropod pests. The results also provide objective information concerning the efficacy of current and new technologies. This project addresses the goals of the USDA-NIFA and the mission of AAES, Alabama, and the U.S. IPM Roadmap: improve the quality of life and food safety. Specific objectives include 1) developing empirical bioassays to determine behavioral effects and the efficacy of insecticides on selected urban pests, 2) determining the impacts of insecticides and ecological factors on pest biological development and physiology, 3) developing field tests to validate empirical bioassays that estimate field efficacy in baits, insecticides, and environmental modifications used to manage urban insect pests, and 4) developing IPM systems for key urban insect pests. Additionally, research findings will be delivered to users, including academics, extension, pest management professionals, the public, and to pesticide developers and manufacturers. Objective 1. Develop empirical bioassays to determine the behavioral effects and estimate the efficacy of insecticides on selected urban pests. A modified experimental design (Hu et al. 2006) will be used to determine the behavioral effects and field efficacy of insecticides/baits on the suppression and elimination of functional termite colonies. Known numbers of field-collected foragers will be stationed in glass aquariums provided with wood and moistened soil. After establishing a tunneling network, a known amount of insecticide will be added to the soil-ground at a location far-most from the food source inside the aquarium. The insecticide carrier will be marked with a dye to allow visibility of exposed termites (via feeding) and the movement of treated soil. High-definition Supervision® video will be used to allow all-time observation of cryptic behaviors of termite colony-mates. The filming signals will be viewed simultaneously on cellphones, iPad, and computers, 24-h/day until the termination of the 40-d study. Standard topical bioassay will be used to determine the effects of selected plant-derived chemicals on household insect pests under laboratory conditions. Selected E.O.s and EOCs, including aliphatic and aromatic chemicals, are those whose efficacy has been documented against other insect pests but the target pests or have been reported against the target pests but need further validation or verification. Susceptible and insecticide-resistant strains will be tested for toxicity comparisons. The resistance ratio (R.R.) for each EOC, insecticide and strain will be calculated using $R.R. = (LD50 \text{ of insecticide-resistant strain}) / (LD50 \text{ of susceptible strain})$. Objective 2. Determine the impacts of insecticides and ecological factors on pest development and physiology. Temperature-influenced survival and development will be investigated in two closely related cockroach species: the domestic German cockroach and the invasive Asian cockroach. The differences between species for the total development period and average lifespan at one temperature will be determined by the number of survivors and the number of newly developed instars through daily observations. Instars will be determined using morphological and digital methods developed by our program (Peterson et al. 2019). Water loss and desiccation tolerance will be measured gravimetrically using the methods we previously developed. Investigated factors include abiotic (temperature, toxicants, etc.) and biotic (insect developmental stage, physiological status, generation, etc.). Percent entire body water content, rate of percent total body water loss, body mass loss, and cuticular permeability at different treatment times will be calculated. Mortality data will determine desiccation tolerance at time intervals during the desiccation experiments. Flow-through respirometry will be used to measure the impact of insecticides on insect respiration patterns. The effects of insecticides on arthropod respiration and water loss will be determined by confining individuals to insecticide-treated surfaces within flow-through respirometers or by dosing individuals with insecticide diluted in acetone.

The hypothesis is that the invested insecticides and environmental factors significantly impact insect development and physiology. Objective 3. Develop field tests to validate empirical bioassays that estimate field efficacy in baits and insecticides. The viability of a new IGR termite bait will be field tested in urban kiwi orchards through international collaboration. The hypothesis is that the novaluron bait can successfully reduce and eliminate termite colonies infesting kiwi plants. Two sites (treatment and control) at each location will be selected. Two sampling methods will be used to determine the baseline termite pressure: 1) ATBS with wooden blocks and blank inspection cartridge (no active ingredient), and 2) the number and length of foraging tubes on the kiwi truck between ground and T-bar. Monitoring stations will be inspected to count the number of termite activities; all kiwi plants will be sampled for tube measurements to provide reliable pressure estimates of the subterranean termites. Bait stations will be inspected monthly for one year. The hypothesis is that the field trials will validate the empirical efficacy of baits and insecticides. Objective 4. Develop IPM for key urban insect pests. IPM strategies such as new insecticides, targeted applications, management of debris and mulches, reducing food and moisture sources, and manipulating habitat conditions will be evaluated in and around infested homes using trapping methods specific to different pests. Traps (sticky, pitfall, baited stations, etc.) will be deployed at locations conducive to pest infestation and be used to determine spatial distribution patterns in the kitchen area (domestic cockroaches) and around homes (ants, termites, and other exterior pests) and population dynamics of the pests. Trap catches will be evaluated before treatment and 1, 2, 4, 8, 12 weeks, or longer after treatment. The correlation between perimeter pest abundance/diversity and house/landscape characters will be investigated at 40 residential homes in Auburn-Opelika, AL. Peridomestic pest abundance (cockroaches, ants, termites, etc.) will be measured biweekly from April through November. The methods producing linear combinations of variables that best describe perimeter pest habitat (i.e., correlations between cockroach abundance and environment) will be added to a predictive model. The refined model will be validated with jackknife bias correction methods and bootstrap confidence intervals. Ten of the 40 selected homes in the study will be designated randomly for model validation. The refined model will identify additional house and landscape characteristics that alter the abundance and diversity of perimeter pests. It will also rank these characteristics for each of the 40 homes based on their effect on pest abundance.

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

The target audiences include scientists (research and teaching), industry (pest control products developers and manufacturers), extension agents, pest management professionals and consultants, homeowners, government agents, private sections, college students, graduate students, and other service professionals tasked with controlling arthropods in and around homes, businesses, and public facilities. The project results and discoveries will be made available to scientists and technology developers through various proper means, including publications in scientific journals, technical reports, and magazines of professional and general interest, presentations at conferences, meetings, workshops, lectures to students and trainees, etc. The target audience benefits from the results that would increase their scientific knowledge (fundamental and applied), promote collaborations with researchers of diverse fields, improve experimental designs and protocols, inspire ideas and exploration of new research fields, develop competitive proposals, and help develop more efficient, safer, and cost-effective control programs and products. The project results will be disseminated to target educators and end-users via on-site demonstrations, field trials, extension workshops and articles, news releases (social media, news media), local activities, etc. Increased awareness of new knowledge and the advances of sustainable IPM programs empower capacity in adopting and implementing IPM programs. Referred publications in 2022: • Oladipupo* SO, Hu XP, and Appel AG. 2022. Essential oils in urban insect management – a review. *Journal of Economic Entomology*. 115(5): 1375-1408, <https://doi.org/10.1093/jee/toac083> • Oladipupo* SO, Wilson AE, Hu XP, and Appel AG. 2022. Why do insects close their spiracles? A meta-analytic evaluation of the adaptive hypotheses of discontinuous gas exchange in insects. *Insects*. 13(2): 117-121. <https://doi.org/10.3390/insects13020117> Presentations at scientific and professional meetings in 2022: • Hu XP and Liu Y. 2022. Self-introduced egg-parasitoid established and suppressed an invasive pest: a case study. Paper# 113056. XXVI International Congress of Entomology. Helsinki, Finland • Hu XP. 2022. The rising threat of Formosan subterranean termites: range expansion and increasing activities in Alabama. ESA, ESC, and ESBC Joint Annual Meeting: Entomology as inspiration: insects through art, science, and culture. Vancouver, British Columbia, Canada. Poster ID:1286489 • Hu XP and Appel AG. 2022. The Asian cockroach: biology and management implications from the research. NCUE Cockroaches Symposium, Salt Lake City, UT. • Oladipupo S, Laidoudi Y, Beckmann J, Hu XP, and Appel A. 2022. Cockroach-associated Wolbachia imitates the pattern in their bed bug host-prey. NCUE 2022. Salt Lake City, UT. • Oladipupo S, Beckmann J, Hu XP, and Appel AG. 2022. Endosymbiont research cross-continental tool for urban insect management. ESA-SEB&APS-CD meeting, San Juan, PR. • Jeon AS, Hu XP, and Appel AG. 2022. Water content and cuticular permeability of six *Pycnoscelus* species. ESA-SEB & APS-CD meeting, San Juan PR. Demonstrations in 2022: • Housing IPM (24) • Target-application of IGR into channel drain to control drain moth and phorid flies in public structure (2) • Steps to get rid of residential pantry pests (6) • Ways to prevent, monitor, and control venomous spiders in kids' centers (2) • Termite inspections (2). Multistate collaboration in 2022 • S1076 (2018 - 2023): Fly management in animal agriculture systems and impacts on animal health and food safety. Mass and Social Media in 2022 • Total of 28 Peer-reviewed articles in 2022 • Total of 11 Online articles in 2022 • Total of 6

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

This project addresses the goals of the USDA-NIFA and the mission of AAES and Alabama/U.S. IPM Roadmap, Alabama's needs, and aligns with the PI's research interests and departmental field of specialization. Anticipated impacts of the new knowledge and increased IPM implementation are economic, environmental, and public health gains through the reduction in pesticide use and pest infestations, efficacy increase of IPM tactics and systems, reduction in the cost of pests and control practices, safer urban environment for lives, safer and healthier housing, and ultimately, improved qualities of life and food safety.

Southeastern US Aquatic Disease Diagnostics & Surveillance

Project Director

Stephen Bullard

Organization

Auburn University

Accession Number

1025885



Southeastern US Aquatic Disease Diagnostics & Surveillance

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

The aim of this project is to increase capacity for fish disease diagnostics. Demand for fish disease diagnostics clearly exceeds existing infrastructure. This project benefits state fisheries agencies already in cooperation with Auburn University while also providing a supporting role to federal agencies. The project hastens further university partnerships in fish health, including the mission critical focus areas of state and federal hatchery system biosecurity, surveillance of wild fish populations for new and emerging pathogens (including exotic invasive species and aquatic nuisance species), and in-service training and cross-fertilization of methodologies and approaches.

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.

Need for Aquatic Disease Research and Disease Surveillance in the Southeastern US.

1. Basic Research: Little is known about the identity, host range, geographic distribution, pathological effects, interactions with human health, and effect on wild populations of parasites and pathogens affecting Southeastern US endemic aquatic wildlife.

2. Pedagogy: The next generation of disease specialists who have specific taxonomic knowledge of the pathogens ranging in The Southeastern US must be trained at the university level so as to safeguard the future of The Southeastern US's aquatic natural resources.

3. Aquatic Resource Management: Stakeholders (e.g., recreational and commercial anglers, wildlife managers, those who use Southeastern US rivers and coastlines for recreation) need distilled, reliable scientific information regarding the pathogen status of parasites that infect fishes and invertebrates in rivers and coastal waters of this region.

4. Environmental Science: Baseline information on the health status of endemic aquatic species, many of which are threatened and endangered, is valuable. Pollution events or long-term changes in atmospheric conditions (e.g., global warming) could have a long-standing negative overall effect on those already-imperiled populations of aquatic invertebrates and vertebrates.

5. Aquaculture: Alabama's aquaculture industry, including freshwater ponds and potential marine offshore cage culture, will be able to control diseases more effectively if armed with accurate biological information on the identity, life history, and pathobiology of specific fish pathogens ranging near proposed aquaculture sites.

Appropriateness of research for mission of AAES. AAES supports research that 1) establishes and enhances Alabama's economically viable agriculture, forestry, and related business and industries, 2) promotes environmentally- and socially-responsible development of Alabama's natural resources, 3) improves the quality of life for all Alabamians, and 4) makes available new knowledge discovered through research. The present study fulfills each of those objectives, respectively, by 1) highlighting and studying diseases that could emerge and threaten the economic viability, health, and productivity of cultured

fishes and invertebrates, 2) providing data that can assist natural resource managers in solving practical problems relating to disease issues, 3) helping prevent potential zoonotic agents from harming the well-being of Alabamians, and 4) publishing the results of these scientific investigations in peer-reviewed literature and popular press outlets when and where appropriate.

Specific relevance of research. The primary purpose for conducting this study is that there is a wide gap of knowledge regarding the specific parasites and pathogens that are harming Alabama's aquatic natural resources. Additionally, we lack specific information on how anthropogenic modifications to aquatic habitats could alter the status of wildlife and human diseases in Alabama; clearly there is great potential for new emerging diseases to come into focus and negatively affect industry, recreation, and public health. Pressures on water resources throughout the Southeastern United States are increasing exponentially as the human population increases. For example, Georgia faces periodic water shortage crises. Although seemingly limited in geographic scope now, such a crisis could materialize in other neighboring states that utilize those same water resources. Typically, a change in the 'natural' state of the aquatic environment, e.g., environmental perturbation or pollution effects, can have severe, negative affects on the virulence or pathogen status of a parasitic organism, i.e., sometimes normally benign parasites can become pathogenic if environmental conditions change such that the host organism becomes stressed or is otherwise compromised immunologically. Given that stream habitats and coastal zones are facing threats from human population growth and urban development, it seems highly likely that such environmental changes will affect some parasite-host relationships. In this sense, the status of the parasite-host relationship can be regarded as a sentinel for detecting environmental changes that deviate from normal.

Dissemination of results and information derived from this study. This new information gained from the proposed project will be disseminated at multiple levels: 1) through professional development of the PI and subsequent instruction of undergraduate students in the College of Agriculture at Auburn University, 2) through training of MS and PhD students who work in the laboratory of the PI, 3) through workshops and public outreach opportunities that engage Alabamians of all age groups, 4) through interactions with federal and state aquatic wildlife biologists, and 5) through publication of data and results in peer-reviewed scientific literature.

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

This new information gained from the proposed project will be disseminated at multiple levels: 1) through professional development of the PI and subsequent instruction of undergraduate students in the College of Agriculture at Auburn University, 2) through training of MS and PhD students who work in the laboratory of the PI, 3) through workshops and public outreach opportunities that engage Alabamians of all age groups, 4) through interactions with federal and state aquatic wildlife biologists, and 5) through publication of data and results in peer-reviewed scientific literature (see below)...

PUBLICATIONS:

139. Truong*, TN, SS Curran, FB Reyda, M Horton, SA Bullard. *Submitted 10 Nov 2022.* Resurrection and revision of *Plesiocreadium* Winfield 1929 (Digenea: Macroderoididae) with an updated phylogeny and supplemental description of its type species from rivers of Arkansas, Tennessee, Mississippi, and New York. **Journal of Parasitology** XX(XX): xxx-xxx.

138. Vaughan, DB, KW Christison, H Hansen, SA Bullard. *Submitted 9 Nov 2022.* Hexabothriid species may have extensive distribution ranges reflecting multiple host species: evidence from three new South African records. **Parasitology Research** XX(XX): xxx-xxx.

137. Curran, SS, R Gonzalez, SA Bullard. *Submitted 20 Oct 2022.* Molecular characterization of sporocysts and cercariae (Digenea: Bucephalidae) infecting the eastern oyster, *Crassostrea virginica* from Virginia. **Journal of Parasitology** XX(XX): xxx-xxx.

136. Knudson*, HP, SS Curran, TN Truong*, HR Dutton*, SA Bullard. *Submitted 20 Oct 2022.* *Encyclobrephus brevivitellus* n. sp. (Digenea: Plagiorchiodea, *incerta sedis*) infecting the Mekong snail eating turtle, *Malayemys subtrijuga* in the Mekong River, Vietnam, and phylogenetic analysis. **Journal of Parasitology** XX(XX): xxx-xxx.

135. Ksepka*, SP, SA Bullard. 2022. *Submitted 13 Sept 2022.* A new species of *Henneguya* Thélohan, 1892 (Cnidaria: Bivalvulida: Myxobolidae) infecting the submucosa of the intestine and pyloric caeca of red drum, *Sciaenops ocellatus* (Linnaeus) (Perciformes: Sciaenidae) from coastal Alabama. **Parasitology Research** XX(XX): xxx-xxx.

134. Poddubnaya, LG, MB Warren*, SA Bullard. *Accepted 14 Nov 2022.* Foregut ultrastructure of adult *Sanguinicola volgensis* (Rasin, 1929) McIntosh, 1934 (Digenea: Aporocotylidae). **Journal of Parasitology** XX(XX): xxx-xxx.

133. Ksepka*, SP, JM Rash, SA Bullard. 2022. Two new species of *Myxobolus* (Myxobolidae) infecting the gill and scales of the smallmouth bass, *Micropterus dolomieu* (Centrarchiformes: Centrarchidae) in the French Broad River Basin, North Carolina. **Parasitology International** 91(2022): 102615.

132. Andres, MJ, RB Blaylock, SA Bullard. 2022. In memoriam: Dr. Robin Miles Overstreet 1 June 1939 – 21 May 2022. **Journal of Parasitology** 108(5): 513-516.

131. Bullard, SA and HR Dutton*. 2022. Resolving the paraphyletic turtle blood flukes: Revision of Spirorchidae Stunkard, 1921 and proposal of Carettacoliidae Yamaguti, 1958, Haplotrematidae (Stunkard, 1921) Poche, 1926, Baracktreematidae n. fam., Plattidae n. fam., and Atamatamidae n. fam. **Journal of Parasitology** 108(6): 553-564.

130. Womble, MR and SA Bullard. 2022. Azygiid parasites of North American endemic pleurocerids and centrarchids: revision of *Leuceruthrus* Marshall and Gilbert, 1905 (Digenea: Azygiidae), description of two new species, and phylogenetic analysis. **Journal of Parasitology** 108(4): 374-394.

129. Bullard SA, F Moravec, SP Ksepka*, MB Warren*, HR Dutton*, DG. Huffman, RPE Yanong. 2022. *Huffmanella* cf. *huffmanella* (Nematoda: Trichosomoididae) infecting swim bladder, peritoneum, and gonad of variable platyfish, *Xiphophorus variatus* (Cyprinodontiformes: Poeciliidae) and eastern mosquitofish, *Gambusia holbrooki* (Poeciliidae) in Florida; taxonomy, phylogenetic analysis, and pathological changes. **Parasitology Research** <https://doi.org/10.1007/s00436-022-07570-z>.

128. Curran, SS, DM Calhoun, W Tkach, MB Warren*, SA Bullard. 2022. A new species of *Prosorhynchoides* Dollfus, 1929 (Digenea: Bucephalidae) infecting chain pickerel, *Esox niger* Lesueur, 1818 (Perciformes: Esocidae) from the Pascagoula River, Mississippi, U.S.A. with a phylogenetic analysis and the first nucleotide-based evidence of a 3-host bucephalid life cycle. **Comparative Parasitology** 89(2): 82-101.

127. Fornari, DC, S Peixoto, SP Ksepka, SA Bullard, W Rossi, DE Nuzback, DA Davis. 2022. Effects of dietary mycotoxins and mycotoxin adsorbent additives on production performance, hematological parameters, and liver histology of Nile tilapia (*Oreochromis niloticus*). **Toxins*** (*this could be a predatory journal; "Toxins" is an MDPI journal; this paper was accepted within 4 business days and with no substantive reviews nor a clearly identified editor or associated editor).

126. Truong*, TN, SS Curran, FB Reyda, JM Rash, SA Bullard. 2022. *Plagioporus wataugaensis* n. sp. (Digenea: Opecoelidae) infecting intestine of northern hogsucker, *Hypentelium nigricans*, and white sucker, *Catostomus commersonii*, (Cypriniformes: Catostomidae) from the eastern U.S.A., including an emended diagnosis, key to Nearctic congeners, and phylogenetic analysis. **Parasitology International** (2022): 102580.

125. Curran, SS, MB Warren*, SA Bullard. 2022. New species of *Bacciger* (Digenea: Gymnophalloidea: Baccigerinae: *incertae sedis*) infecting the American gizzard shad, *Dorosoma cepedianum* (Lesueur, 1818), and molecular characterization of *Cercaria rangiae* Wardle, 1983, from southeastern, U.S.A. **Comparative Parasitology** 89(1): 9-29.

124. Dutton*, HR, LH Du Preez, M Urabe, SA Bullard. 2022. *Paraharmotrema karinganiense* n. gen., n. sp. (Digenea: Liolopidae) infecting the intestine of serrated hinged terrapin (*Pelusios sinuatus*), east African black mud turtle (*Pelusios subniger*), and South African helmeted turtle (*Pelomedusa galeata*) and a phylogenetic hypothesis for some liolopid genera. **International Journal for Parasitology: Parasites and Wildlife** 17(2022): 2213-2244.

PRESENTATIONS

33 platform presentations in 2022 (no room to paste titles)

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

Fish health inspections are critical because they are the “front line defense” preventing the spread of diseases that can harm inland natural resources and fish culture systems throughout the U.S., and especially in Alabama. Generations of Alabamians believe that fishing and enjoying healthy, clean rivers should be protected and conserved for their families and future generations. Pristine rivers, abundant fish, and thriving fisheries generate jobs and revenue for rural communities, for example, by promoting inland sport fish-based tourism (hotels, restaurants, tackle/bait, charter boats) and fish farming (baitfish, sport fish, food fish). However, the current capacity for conducting fish health inspections and fish disease surveillance cannot meet current and projected demand. As the oldest (est. 1965) continuously operated university-based fish disease diagnostics lab in the U.S., Auburn University’s Cooperative Fish Parasite and Disease Project is uniquely qualified to bolster the biosecurity of the southeastern US’s aquatic natural resources.



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

This project is focused on understanding how genetic diversity varies and evolves in wild populations. We are also interested in the interaction of genetics and diseases, and how these interact with fitness to influence population stability. Ultimately, our goal is to conduct research that dissects the mechanistic relationships between these evolutionary forces to increase society's ability to predict extinction risk.

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 my group has made progress on understanding the interactions between genetic diversity and extinction risk by:

1. Designing computational approaches to understanding genetic diversity patterns across genomes in new ways
2. Completing an analysis on the probability of invasive species invading new areas and how we might control this in sensitive areas and ecosystems
3. Summarizing the interaction between avian malaria (an important but devastating disease in some areas) and genetic diversity/other control methods
4. Outlined how the epigenome, or the portion of the genome that does not code for proteins but instead controls how often proteins are created, can inform ecology, evolution, and conservation
5. Created and annotated a reference genome assembly to be used in further genomic data analyses

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

We have made substantial progress in our understanding of genome diversity patterns and extinction risk as well as how those interact with disease/extinction risks. In addition, I have collaborated on a note outlining why these kinds of data are important to consider in conservation contexts, something that is often overlooked. Finally, we have made efforts to include epigenetic information in our analyses because this may also be an important consideration when predicting extinction risk.

Publications and preprints

1. **Willoughby JR**, McKenzie BA, Ahn J, Steury TD, Lepczyk CA, Zohdy S. **2022**. Mosquito invasion via the global shipping network is slowed in high-risk areas by on-shore and ship-board monitoring. *BioRxiv*. 10.1101/2022.08.29.505734 (preprint).
2. Harder AM*, Kirksey KB*, Mathur S, **Willoughby JR**. **2022**. Detectability of runs of homozygosity is influenced by analysis parameters as well as population-specific demographic history. *BioRxiv*. 10.1101/2022.09.29.510155 (preprint).

3. DeWoody JA, Jeon JY, Bickham JW, Heenkenda E, Janjua S, Lamka GF*, Mularo AJ, Black AN, Brüniche-Olsen A, **Willoughby JR. 2022.** The Threatened Species Imperative: Conservation assessments would benefit from population genomic insights. *Proceedings of the National Academy of Science*. 119:e2210685119.
4. Miranda Paez A*, Chalkowski K, Zohdy S, **Willoughby JR. 2022.** Management of avian malaria in populations of high conservation concern. *Parasites & Vectors*. 15: 208.
5. Dunning K, Johnson G, Wally K, **Willoughby JR**, Williamson R, Corvey K, Becker M, Moorman T. **2022.** Application of the policy regime framework to understand COVID-19 policy response in the southeast U.S.: How RAPID research can provide lessons learned after a public health crisis. *Frontiers in Sociology*.
6. Lamka GF*, Harder AM, Sundaram M, Schwartz T, Christie MR, DeWoody JA, **Willoughby JR. 2022.** Epigenetics in ecology, evolution, and conservation. *Frontiers in Ecology and Evolution*. 307 [10.3389/fevo.2022.871791](https://doi.org/10.3389/fevo.2022.871791).
7. Harder AM*, Walden KKO, Marra NJ, **Willoughby JR. 2022.** High-Quality Reference Genome for an Arid-Adapted Mammal, the Banner-Tailed Kangaroo Rat (*Dipodomys spectabilis*). *Genome Biology and Evolution*. 14 evac005.
8. Miranda Paez A*, Sundaram M, **Willoughby JR. 2021.** Comparison of minimally invasive monitoring methods and live trapping in mammals. *Genes*. 12 1949.

Data and policy communications

1. R Shiny app: Use of COVID-19 Information Sources in the American Southeast; built to support NSF Grant No. G00013647, *RAPID: A participatory study of how decision makers and marginalized communities in the U.S. Southeast consume and act on scientific information to mitigate COVID-19*; Harder AM*, **Willoughby JR**, Dunning KH https://avrilmharder.shinyapps.io/multitabbed_app/?_ga=2.148799479.1530367290.1657298250-71991908.1656603381
2. Public comment on U.S. Fish and Wildlife Service Docket ID No. FWS-HQ-ES-2021-0033: Comment written in support of proposed rule change to allow experimental populations to be established outside of their “historic” ranges; Harder AM*, **Willoughby JR**, Lamka G*, Swank A. <https://www.regulations.gov/comment/FWS-HQ-ES-2021-0033-0290>

Presentations

1. Lamka G, **Willoughby JR. 2022.** Eco-evolutionary models of population decline: how much migration is necessary for at-risk populations. Society for the Study of Evolution Conference.
2. Mwema T, **Willoughby JR. 2022.** The efficacy of *Beauveria bassiana* in controlling mosquito vectors. CFWE Open House.
3. **Willoughby JR. 2022.** Interaction of environmental, genomic, and epigenetic influences on individual fitness in banner-tailed kangaroo rats. SEEP workshop: Integrating society, ecology, evolution, and plasticity to advance urban evolutionary ecology. Arizona State University, NSF workshop.
4. Lamka G, **Willoughby JR. 2021.** How can we best use epigenetic data and theory in ecology, evolution, and conservation? International Congress for Conservation Biology.

5. Miranda Paez A, **Willoughby JR**. 2021. Estimating sizes of wild populations: non-invasive methods are more sensitive than traditional trapping approaches. International Congress for Conservation Biology.
6. Garugu SD, **Willoughby JR**. 2021. Influence of range size and genetic diversity on invertebrate conservation. International Congress for Conservation Biology.
7. **Willoughby JR**. 2021. Metabolic rate influences divergence in vertebrates. International Congress for Conservation Biology.
8. Lamka G, **Willoughby JR**. 2021. Epigenetics in ecology, evolution, and conservation. School of Forestry and Wildlife Sciences Graduate Symposium.

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

In addition to the technical and peer-reviewed manuscripts my research group published, we also created three outputs aimed at the general public:

1. We designed a web-based application to allow anyone, but specifically local decision makers, to access and apply information about what kinds of data and messaging their communities are likely to respond to positively
2. We released a public comment on the proposed ESA rule change to extend introductions outside of historic ranges
3. We created a visula display for Weagle Woods outlining how insecticide resistance develops and why this process is important for pest management

Developing positive feedbacks between agriculture and conservation of freshwater organisms III

Project Director
Jim Stoeckel
Organization
Auburn University
Accession Number
1025477



Annual Report

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

The southeastern United States hosts the greatest diversity of freshwater mollusks and crayfish in the world and also hosts established and growing warmwater aquaculture inudstries. Unfortunately, wild population sizes and species diversity are undergoing drastic, long-term declines, and the aquaculture industry also faces many challenges. This project seeks to develop positive feedbacks between agriculture and conservation by adapting techniques developed for agriculture for conservation purposes and techniques developed for conservation for agriculture purposes.

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 2022, we applied research approaches typically used in conservation to better understand the physiological causes of late-summer mortality in low-salinity shrimp aquaculture ponds, and to investigate potential differences in thermal tolerance between diploid and triploid oysters for the off-bottom oyster aquaculture industry. We also applied diagnostic techniques used to monitor diseases in aquaculture to document the first report of white spot disease in wild populations of Alabama

crayfish. We applied levee sealing techniques from aquaculture (i.e. Benseal) to control of invasive species populations. Finally, we used standard ecotoxicology techniques to investigate potential impacts of an emerging contaminant of concern – PFAS- on oyster aquaculture in the northern Gulf of Mexico.

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

Academic: Study results were disseminated to the academic audience via talks and publications.

Hussain, A.S., K. Fogelman, H. Abdelrahman, L. Roy, and J. Stoeckel. accepted with minor revisions. Relationship between aerobic scope and upper thermal limits of Pacific white shrimp (*Litopenaeus vannamei*) in low-salinity culture systems. Aquaculture.

Fogelman, K., A. Hussain, K. Boyd, P. Jordan, H. Abdelrahman, L. Roy, and J. Stoeckel. 2022. Combining respirometry with enzymatic assays to investigate aerobic scope and thermal tolerance in aquatic invertebrates. RespFest. Canada.

Boyd, K. 2022. Use of laboratory assays to evaluate differences in temperature tolerance between oyster genetic lines and ploidies. Oyster South, Biloxi, Mississippi.

Bates, B., G. Elliott, J. Stoeckel, A. Allert, and M. Wildhaber. 2022. Use of physical blockers to control invasive Red Swamp Crayfish in burrows. Midwest Fish and Wildlife Conference.

Stoeckel, J., G. Elliott, H. Abdelrahman, K. Fogelman, B. Bates, A. Cupp, A. Allert, and L. Nathan. 2022. Linking laboratory and pond studies to evaluate control techniques for Red Swamp Crayfish in surface water and burrows. 2022. International Association of Astacology, Hluboka, Czech Republic.

Boyd, K., W. Kleist Constantino, H. Abdelrahman, S. Rickard, and J. Stoeckel. 2022. Differences in tolerance and responses to thermal stress between diploid and triploid oysters in the northern Gulf of Mexico. Alabama Water Resources Center. Orange Beach, AL

Abdelrahman, A., J.A. Stoeckel, G. Elliott, K. Fogelman, B. Bates, A. Cupp, A. Allert, and L. Nathan. 2022. Linking laboratory and pond studies to evaluate control techniques for Red Swamp Crayfish in surface waters and burrows. American Fisheries Society, Spokane, Washington.

State and Federal Agencies: Following our diagnosis of White Spot Virus Syndrome Virus (WSSV) in Alabama crayfish, the USDA APHIS office was alerted, conducted an investigation, and was able to confirm the first report of WSSV in the State of Alabama. Research on invasive crayfish control techniques were disseminated to managers in various states including Florida, Montana, and Michigan.

Producers: Alabama has a small number of crayfish aquaculture farms. We alerted producers to be on the lookout for WSSV in their ponds. Low salinity shrimp producers in west Alabama have been plagued by late-summer mortality events. Our thermal tolerance research showed that thermal tolerance of shrimp in low salinity systems decreases as they grow towards harvest size and may aid in the development of genetic lines of thermally tolerant shrimp by evaluating the physiological basis of thermal tolerance. Our ecotox research showed that although oysters can bioaccumulate a suite of PFAS compounds that occur in and around Mobile Bay, they can also depurate the PFAS to below detectable levels within 24 hours of being held in clean, PFAS-free water. Furthermore, we found no evidence that their mode of depuration incurs significant energetic costs nor did we find any evidence for increased expression of stress related genes when oysters were exposed to a suite of PFAS compounds.

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

Project activities benefited the public by 1) providing technical support in the form of thermal tolerance information to the small, but developing, low-salinity shrimp industry in west Alabama, 2) providing early warning of a potentially catastrophic disease that is now in Alabama, 3) providing information regarding control techniques for invasive crayfish species that have the potential to incur economic and ecological costs in a large number of states, and 4) providing information on an emerging contaminant of concern to a growing oyster aquaculture industry that will be useful in assessing and insuring food safety as well as assessing potential harm to oysters.



Recreational Fishing in the Cayman Islands and Coral Reef Conservation: Multi-stakeholder Research to Inform Decision-makers

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

How does sustainable artisanal fisheries management occur in Florida and the Caribbean focusing on coral reef ecosystems.

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 project has 1 Peer reviewed book under contract with Anthem Press, co-authored with graduate students, expected 2023. This book answers the central research question (How does sustainable artisanal fisheries management occur in Florida and the Caribbean focusing on coral reef ecosystems.) and has assisted in the training of 5 MS students (4 graduated) and 2 PhD students (in progress).

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

The target audience for this Hatch project is natural resource managers and decision-makers sustainably managing coral reefs, recreational/commercial fisheries, and coastal protected areas. Findings are relevant to coastal systems in general because coral reef management deals with linked socio-ecological systems in a way that is similar to linked problems dealt with by coastal managers. Another target audience can be fellow coastal marine and social scientists dealing in coastal zone management and planning.

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

This research has led to 2 OpEds, 16 articles in the news media, 6 radio/podcast appearances, 7 public lectures, 5 outreach events for decision-makers reaching 135 decision-makers, 2 white papers for policy-makers.

Nine peer reviewed publications have resulted from this research using theory, methods, or personnel funded by Hatch. These include:

1. Bailey, S.*, **Dunning, K.**, Morris, D.*, & Williamson, R. (2022). How narratives shape policy: Lessons learned from port projects adjacent to coral reefs in Florida and the Cayman Islands. *Marine Policy*. <https://doi.org/10.1016/j.marpol.2022.105233>. (40%)
2. Elliot, J., **Dunning, K.**, Gulsby, W., Ditchkoff, S. (2022). Training and Experience Increase Classification Accuracy in White-tailed Deer Camera Surveys. *Wildlife Research*. *In press*. (10%)
3. Wang, L.*, Li, F., Meng, K., & **Dunning, K.** (2022). Childhood Socioeconomic Status and Adult Subjective Well Being: The Role of Hope and Sense of Control. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2022.879132>. (33%)
4. **Dunning, K.** (2022). Biodiversity Conservation Policy in Megadiverse Countries: Comparing Policy Systems for 2020 Targets to Inform Management in the Coming Decades. *Journal of Environmental Management*. <https://doi.org/10.1016/j.jenvman.2021.113815>. (100%)

5. **Dunning, K.** (2021). Unlikely Environmental Policy-making During the Trump Administration: A Multiple Streams Analysis of “America’s Most Successful Conservation Program.” *Politics and Policy*. <https://doi.org/10.1111/polp.12448>. (100%)
6. Larsen et al. (Including **Dunning, K.**) (2021). The future of wildlife conservation funding: what options do U.S. college students support? *Conservation Science and Practice*. <https://doi.org/10.1111/csp2.505>. (10%)
7. Lepczyk, C., **Dunning, K.**, Williamson, R. (2022). Response to Crowley et al. 2020. *Frontiers in Ecology and the Environment Write Back Letters*. <https://doi.org/10.1002/fee.2428> (33%)
8. Nagy et al. (Including **Dunning, K.**) (2021). Harnessing the NEON Data Revolution to Advance Open Environmental Science with a Diverse and Data-Capable Community. *Ecosphere*. <https://doi.org/10.1002/ecs2.3833> (10%)
9. **Dunning, K.** (2021). How are managers responding to local and global ecological stressors? The case of Indonesian co-managed coral reefs in the Anthropocene. *Marine Policy*. <https://doi.org/10.1016/j.marpol.2021.104560> (100%)

Aquaculture/Aquaponics Education

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7002287



Aquaculture/Aquaponics Education - annual

Final Result

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

As our population grows and natural fisheries stocks dwindle we will need a sustainable source of high quality protein. By all accounts, aquaculture will play an increasingly important role in filling this need. However, aquaculture is poorly understood and often misconstrued by the media. As aquaculture expands and the popularity of aquaponics grows there will be a need for teachers knowledgeable about aquaponics (to create a skilled workforce), a mechanism to keep aquaculture producers up to date with the latest research and production information, and scientifically accurate and entertaining multimedia to reach the public to create a more aquaculture literate society.

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.

Twenty-one teachers from eight states attended the 5-day Aquaponics 101 Teacher Workshop and increased their aquaculture knowledge by 24%. The teachers felt that value of the workshop was worth \$363 more than what they paid and teaching materials and resources for use in their classrooms. A total of 856 producers, researchers, teachers, students and Extension personnel registered for four webinars and 451 attended the live presentations (this lower number is likely the result of the time difference between countries) . These webinars reached 31 states and 30 countries and provided 314 hours of education. These webinars were recorded and posted to several YouTube channels and received many views after the live event.

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

In addition to the ACES YouTube channel, the webinars and educational videos produced in 2022 and prior years reside on two other topical (aquaculture) channels. In 2022, these videos received a total of 125,113 views providing more than 10,580 hours of education to people around the world.

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

Using a three prong approach to building awareness and skills related to aquaculture. 1) We provided professional development opportunities for teachers to build their aquaculture knowledge and teaching capacity. 2) We provided webinars with well known aquaculture experts to provide learning opportunities for producers, researchers and students regardless of their location. 3) we made recordings and videos available via YouTube.

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 continue this project and hope to work with the Alabama State Department of Education to create a expanded opportunities for science and agriculture teachers and students to receive aquaculture training and be able to utilize aquaculture and aquaponics as a cross curricular teaching platform.

Number of Publications: Extension - 1 Research - 2 Total (calculated) - 3

Oyster Gardening on the Gulf Coast

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7002297



Oyster Gardening on the Gulf Coast

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

An estimated 80% of the world's oyster reef resources have been lost. Recent historic flooding along the northern Gulf of Mexico has led to significant and visible local oyster reef losses. As a result, stakeholders along the northern Gulf of Mexico have expressed an interest in active involvement in restorative activities within local estuarine environments to combat documented losses of ecosystem services associated with oyster reefs. Oyster gardening programs facilitate this involvement, and offer hands on learning opportunities to expand access to and foster a deeper understanding of the ecological and economic role of oysters and oyster reefs within an estuarine system.

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

Production of oysters, in difficult environmental conditions provided additional educational opportunities for the program to share with participants. 2022 allowed lessons learned in two previous years, relative to the impact of freshwater on local shellfish, to be implemented as program participants navigate these system stressors. Utilizing a modification in the timing, stakeholders and participants achieved a positive restoration potential by growing more than 86,000 oysters ready to be planted on restoration sites in Alabama. Mississippi schedules were further modified based on environmental conditions resulting in their harvest being delayed until Spring of 2023. These numbers will be applied to the 2023 totals.

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

Participants in both states are engaging in hands on activities which expose them to the life cycle, care requirements, and ecological benefits of oysters in their local estuarine system. Further, they are able to meet a stated interest in actively engaging in local restorative activities and having a measurable impact through their own production.

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

The restored reef sites benefit the broader public by way of their ecosystem service values. The 2022 production in Alabama, has a restorative potential of 4.26 acres and an economic value of \$107,304.85 (2022 dollars). When combined with the value of volunteer time associated with production and participation in the program, the total Alabama value was calculated to be \$195,357.85.

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.

To avoid heavy spring rains which resulted in significant mortalities in both program and wild oyster populations, Mississippi sites were delayed for 2022 to August. In consultation with Mississippi regulatory authorities, the oyster gardening season for MS was extended into the spring of 2023. No harvest/production/planting numbers are available for MS during 2022. These numbers will be reported in 2023, and we anticipate resuming annual reporting numbers on this new schedule going forward. Further, in AL, some oyster growing areas grew significantly faster than in prior seasons. This resulted in increased weight and space shortages for these participants to manage. In response, we terminated the 2022 season early for these sites, collecting final counts and measurements before planting as we would normally. The impact to the program was a reduction in weeks, and subsequently volunteer hours, which had a negative impact on total program value. We believe this reduction in value is offset by the comfort level of participants, and will result in better volunteer retention and recruitment for future seasons. Finally, there is some interests by some participants in exploring alternative shellfish for restoration efforts. We will investigate the potential of these during 2023. Results are disseminated to communities through social media and newsletters (24) as well as community meetings/presentations used to inform and recruit for the program. One peer reviewed journal article was published in 2022 exploring the relationship between rainfall, salinity and production within the larger watershed in Mississippi (Journal of NACAAS).

The ACES Forage Focus Program: Growing Grass, Growing Profits

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002291



Forage Focus - Annual

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

The ACES Forage Focus program strives to educate stakeholders on sustainable hay and pasture management. Our objectives are to provide a comprehensive set of educational programs for livestock and forage producers in Alabama. Programs will increase the ability of participants to establish and sustain a viable forage base for their operation.

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 target audience for the Forage Focus program consists of both internal and external stakeholders. Internal stakeholders include regional Extension agents, county Extension coordinators, Animal Science and Forage Graduate Students, and faculty/student collaborators in the College of Agriculture and College of Veterinary Medicine at Auburn University. External stakeholders include new and/or beginning forage and livestock producers or land owners, federal agencies, commodity groups, and industry partners.

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

Educational and research activities of the ACES Forage Focus Program aim to increase economic, environmental, and social sustainability of forage and livestock farms in Alabama. This is achieved by promoting activities that 1) enhance land conservation through sustainable agricultural practices and 2) promote a safe and secure food supply through livestock nutrition and animal welfare practices. All of these outcomes directly impact consumers locally, regionally, and nationally.

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

The Forage Focus program conducted 75 activities in 2022 with a total of 1,628 attendees. Throughout the year a total of 6 Forage Field days were held at Alabama Agricultural Experiment Stations or on producer farms. During these field days, attendees were able to view current research projects, as well as learn results of previous projects and how to implement them on their farm. Field days were held at the Wiregrass Research and Extension Center (REC) in Headland, AL, Tennessee Valley REC in Belle Mina, AL, EV Smith REC in Shorter, AL, as well as various producer farms throughout the state.

Five hands-on grazing workshops were held throughout the state. Two were equine specific and the remaining three were for any livestock producer. A total 65 producers were in attendance at the five events. Post-workshop surveys indicated that all the topics were helpful to attendees, as they received positive responses. All of the topics had at least a 0.25 average increase when attendees were asked to rate their knowledge beforehand and knowledge after the program. When asked how likely they would be to adopt concepts from the days segments, on average all three topics were rated "somewhat probable."

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.

Based on post-program surveys and direct feedback from clientele, the program plans to emphasis hands-on educational opportunities and demonstrations for forage/livestock producers in the next year. Supporting educational materials will be developed or revised to distribute along with these resources. Continuing to build scholarly content for the ACES website on livestock and forages is a priority for agents to have as a quick reference resource to address responsive programming.

Number of Publications : Extension - 11 Research - 10 Total (calculated) - 21

Water and Watershed Management

Project Director

Rebecca Barlow

Organization

Auburn University

Accession Number

7002301



Watershed Management - Annual

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

Access to abundant, safe water supplies are critical for maintenance of a prosperous society, community health, and maintenance of ecological integrity.

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

We developed resources and conducted hands-on programs to enhance awareness and implementation of effective watershed education, monitoring, planning, and improvement (e.g., water quality, water quantity, domestic well water)

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

Improved understanding of local water quality and actions to be protective or address problems, identification of private well water quality concerns (E. coli), and proactive planning for agriculture water use to minimize ecological impacts.

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

Potential for improved water quality for recreational users, domestic well water, and ecological communities; improved understanding of future water quantity needs and strategies for planning.

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.

Increase in services offered virtually (online courses, webinars, etc.), extension of communications with other Universities in the state. Efforts will be made to incorporate more diverse stakeholders and offer educational resources in more accessible ways. Not counted in the Extension publications below are digital newsletters (26), blog articles (39), tv interviews (2), ESRI story map (2). Number of Publications: Extension - 15 Research - Total (calculated) - 15

E-waste Management Education Program (EMEP)

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002344



E-waste Management Education Program (EMEP) (ANNUAL)

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

Electronic products in households and businesses considered obsolete, broken, or irreparable are growing tremendously. According to the United Nations, e-waste accounts for 20% of all global waste, with projections rising through 2030. Notably, its management poses an immense challenge and creates a need for heightened education and the adoption of e-waste best management practices (BMPs) that reduce economic and environmental impacts. The target audience for EMEP includes youth, volunteers, homeowners, business owners, professionals, and the general public.

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.

EMEP offered in-person and virtual activities that reached 267 participants, including seniors. It provided education on e-waste pollution, its threat to environmental health, and the benefits of properly disposing of e-waste.

- Two community-based e-waste recycling drives resulted in 140 cars dropping off 2,640 lbs. (1.32 tons) of e-waste.
- Other collaborative recycling efforts resulted in an added 2,839 lbs. (1.47 tons) of e-waste, for a total of 5,479 lbs. of e-waste.
- A total of 18 volunteer hours were provided to EMEP, yielding a dollar value of \$539.10.
- Approximately 116 printer cartridges were recycled via the small electronics recycling program (SERP).

Collectively, these events significantly reduced the e-waste fated for landfills and the environment.

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

The project's activities led to the expanded delivery of educational information, increasing the social, economic, and environmental benefits of responsibly managing e-waste. Unfortunately, some e-waste can take up to 1000 yrs. to decompose thoroughly. So, the target audience adopting environmentally supportive behaviors is paramount.

- The economic gains or dollars generated from the e-waste recycled are estimated to be in the thousands (i.e., pounds of wire @ \$0.8/pound, etc.).
- Increased revenue for the recyclers, cost savings for the public, and reduced electronic production costs are among the economic benefits.

- Participants also learned the 1) types of e-waste, 2) risks associated with e-waste, and 3) benefits of reusing, reducing, and recycling e-waste.

- The target audience will ultimately benefit from improved environmental quality due to reduced e-waste contamination and carbon emissions (CO₂).

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

The e-Stewards Global Impact E-waste Calculator results demonstrate the environmental benefits to the broader public. It revealed that EMEP activities contributed to the following outcomes:

- Deferred 7,637 lbs. of CO₂ from entering the atmosphere.
- Diverted 157 lbs. of toxic metals from local landfills.
- Saved over 1,850 lbs. of critical precious metals, including 242 lbs. of copper, 112 lbs. of aluminum, and 1496 lbs. of steel.

Sixteen metals can be reclaimed from e-waste. This minimizes the need for economically costly and carbon-intensive mining processes that can harm the environment. Moreover, many of the metals recovered cannot be replenished during our lifetime, so their conservation is invaluable.

- The WEEE4Future E-waste Calculator further underscored impacts on the broader public. Results showed CO₂ savings equal to a 536-mile drive.
- The application of additional EPA conversion factors revealed that 5,479 lbs. of e-waste would help save 218,174 hrs. of electricity [Montgomery County Environmental Calculator (Maryland, USA)].
- The Clover Imaging Group Environmental Calculator revealed the 116 recycled printer cartridges were equivalent to offsetting CO₂ emissions from more than 41.03 gallons of gasoline, the carbon sequestered by 6.08 tree seedling(s) grown for ten years, or 0.47 acres of pine or fir forests.
- The recycled cartridges provided 286 lbs. of plastic, aluminum, steel, copper, and other metals.

The Greenhouse gas equivalencies were determined by applying EPA's WARM Emissions Factors and Greenhouse Gas Equivalencies Calculator to average weights.

- The results showed deferred CO₂ emissions, diversion of toxic metals from the environment, and considerable cost savings; hence benefits for the broader public are conserved energy and natural resources, reduced environmental pollution, and increased economic gains.
- The efforts also prevented further ecological degradation, reduced hazardous waste, and helped create local job opportunities.
- The project also demonstrates the significance of good environmental stewardship to individuals, businesses, and communities. To this end, these outcomes are significant and provide social, economic, and environmental advances for the broader public

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

Several county staff voluntarily separated from the university to pursue relocation with family and other opportunities. These changes in staffing from a team of six to a team of three significantly affected the number of activities implemented via EMEP and the outputs and outcomes achieved in FY 2022. The Team consisted of one State Specialist and two Urban Regional Extension Agents on a 50% split appointment. The hiring process to fill the vacancies is ongoing and should be completed in the upcoming year. There was also difficulty locating recyclers in some areas of the state, which contributed to a reduction in the number of recycling events offered in FY2022.

Synergistic Efforts to Reduce Pharmaceuticals Impacts on the Environment (SerPIE)

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002382



Synergistic Efforts to Reduce Pharmaceutical Impacts on the Environment (SerPIE) (ANNUAL)

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

There is growing concern over the impacts of pharmaceuticals and personal care products (PPCPs) on human, animal, and environmental health. These chemicals have been detected in aquatic ecosystems worldwide and are deemed contaminants of emerging concern (CECs). Unfortunately, their potential toxicity remains unknown, and that uncertainty poses an immense threat to all living organisms. SerPIE seeks to advance knowledge and promote the benefits of using safe, effective methods to dispose of expired, unused, and unwanted PPCPs. The target audience includes youth, seniors, educators, homeowners, pet owners, animal producers, veterinarians, and other professionals.

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 diverse audience was engaged via webinars, workshops, demonstrations, campaigns, and drug take-back initiatives. The activities offered education and resources that minimized impacts on human, animal, and environmental health by enhancing literacy concerning PPCPs. The quantities of PPCPs stockpiled in homes and fated for the environment were significantly lowered through planned drug take-back events, permanent drug drop-off boxes that offered year-round disposal, and the sharing of other eco-friendly PPCP resources.

- 846 participants dropped off 1,575 lbs. of medication at 9 drug take-back events.
- 18 permanent drug drop-off boxes received approximately 1,160 lbs. of medication.
- Approximately 2,735 lbs. of expired/unwanted medicines were collected via these activities.
- The majority of the medications were prescription drugs followed by over-the-counter (OTC) medicines.
- 650 Deterra drug deactivation and disposal systems were provided to the public, offering a free, simple and effective way to dispose of medication at home.
- 374 participants took the lock-your-meds pledge, promising to implement learned BMPs. In short, the activities helped citizens safeguard their homes and the environment from PPCPs.

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

Survey results from workshops indicated knowledge gains for 96% of the target audience. Participants learned the 1) benefits of properly disposing of PPCPS, 2) how pharmaceuticals enter waterways, and 3) the health hazards associated with improperly disposing of medications.

- 90% of the respondents planned to share what they learned with family and friends.
- 93% felt they achieved an environmental expectation of protecting the environment.
- 74% felt they achieved a social expectation of providing a safer home for their family.
- 64% felt they achieved an economic expectation of saving money.

The demographics were as follows: [n=90] Gender: Male (7%), Female (93%); Race: Black (33%), White (46%), Other (21%); Ethnic Background: Hispanic (6%) Or Non-Hispanic (94%).

Post-delayed surveys revealed the adoption of recommended BMPs as follows (n=49):

- 44% of respondents had participated in a local drug take-back program.
- 46% of respondents had dropped off unwanted medicine at a local drug drop-off box.
- 30% of respondents had taken the lock-your-meds pledge.

Overall, the reduction in PPCPs improved the target audience's social, economic, and environmental conditions. They are now better equipped to manage and dispose of their unwanted medicines and are aware of their adverse actions.

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

The DEA National Prescription Drug Take-Back Day has collected more than 16 million lbs. of drugs, with more than 109,718 lbs. coming from Alabama alone. In 2022, Alabama hosted 118 collection sites that received 8,717 lbs. of drugs. Notably, SerPIE's activities contributed significantly to these outcomes. In short, the broader public benefited from the decline in medicines being stockpiled in homes and fated for the environment. They benefited from decreased soil and water pollution and improved environmental and public health. Equally important, the efforts helped stem the pandemic use, misuse, and abuse of prescription and opioid drugs by minimizing easy access within the home. All these collaborative efforts with local police had positive outcomes for the broader public. The broader public better understands the environmental safeguards germane to properly managing and disposing of unwanted medicines.

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

Several county staff members voluntarily separated from Extension due to the relocation of their families to other geographic locations and other reasons beyond our control. These changes in staff from a team of six to a team of three significantly affected the number of activities implemented via SerPIE and the outputs and outcomes achieved in FY 2022. The Team consisted of one State Specialist and two Urban Regional Extension Agents on a 50% split appointment. The hiring process to fill the vacancies is ongoing and should be completed in the upcoming year.

Urban Environmental Science Education Program (UESEP)

Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002383



Urban Environmental Science Education Program (UESEP) (ANNUAL)

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

The protection of our environment is an important issue. As urban communities continue to grow and expand, topics such as natural resource conservation, wildlife management, and climate resiliency are progressively becoming a concern for many families. Protecting the environment and its renewable and nonrenewable resources is crucial, and enhanced knowledge and understanding of pressing environmental issues are paramount. The Urban Environmental Science Education Program (UESEP) provides adults and youth with natural resource conservation strategies that lead to improved environmental awareness and stewardship.

The target audience for UESEP includes K-12 youth, adults, educators, volunteers, professionals, private forestland and rangeland owners, and the general public, especially those underrepresented.

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 2022, UESEP reached 9,363 direct and over 100,280 indirect participants through 165 activities, fostering improved stewardship within urban communities. Its activities included workshops, webinars, interactive demonstrations, story time sessions, and explorations focused on environmental issues. In addition, it enhanced environmental literacy through an array of programs.

- The Eco-friendly Fridays Environmental Education Virtual Webinar Series offered practical solutions to help citizens reduce their ecological footprint (n=187).
- Camp Conservation provided K-12 teachers CEUs and strategies to enhance student learning outcomes by integrating environmental education into STEM (n=62).
- The Lend an EAR: Environmental Awareness through Reading fostered a greater appreciation for natural resources through reading [youth (n= 4,593)] and [teachers (n=115)].
- The Lend an EAR Reading Challenge encouraged 2nd through 5th graders to read more STEM books (n=239).
- The collaborative At Home Beekeeping Virtual Webinar Series offered educational information and resources to beekeepers (n=2,624).

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

The activities increased awareness of natural resource conservation, wildlife management, forestry, energy and waste management, and disaster preparedness. The results were as follows:

- The Eco-friendly Fridays Series offered 7 virtual sessions and garnered 187 participants.
- 96% of respondents increased their knowledge of environmental issues (n=94).
- Comments: "Great presentation!" "I learned so much." "Very Informative."

Post-delayed surveys revealed the adoption of recommended BMPs as follows (n=107):

- 95% of respondents had recycled glass, paper, plastic, or aluminum in their homes.
- 86% of respondents had created an emergency preparedness kit.
- 37% of respondents had tested the drinking water in their homes.
- 54% of respondents had tested the soil in their yards.

The COVID-19 Pandemic has severely impacted youth literacy. Urban and underrepresented youth were introduced to natural resources and disaster preparedness via the Lend an EAR Story Time Series. Demographics [(n=95) Gender: Male (51%), Female (49%); Race: Black (85%), White (5%), Other (10%); Ethnic Background: Hispanic (14%) or Non-Hispanic (86%), Grade: 4th (44%), 3rd (22%), 2nd (21%), 5th (13%)].

The survey results were as follows:

- 20 STEM books were shared with 4,593 youth.
- 79% of youth wanted to read more because of the Lend an EAR virtual storytime series.
- 80% of youth felt the story time series increased their knowledge of natural resources.
- 89% of youth felt reading the books aloud helped them understand them better.
- 76% of youth felt the story time series made them want to protect the environment.
- 30% of youth felt reading was important.
- 20% felt it increased their vocabulary.

- Youth Comments: "I love story time." "It made me think." "I love the reading."

Survey results for teachers participating in the Lend an EAR Story Time Series. Demographics [(n=84) Gender: Male (1%), Female (99%); Race: Black (69%), White (26%), Other (5%); Ethnic Background: Hispanic (1%) or Non-Hispanic (99%).

The results were as follows:

- 95% of teachers agreed the books supported their STEM learning outcomes.
- 95% agreed story time was helpful in their student's literacy development.
- 25% agreed their students showed a greater interest in exploring nature and the outdoors.
- 24% agreed their children expressed greater interest in natural resource topics.
- Teacher Comments: "My children express a greater interest in science." I loved the stories that were chosen for our reading, and I really love the hands-on." "I enjoy watching the students listening to the presenter and interacting. Allowing them to read aloud helps with their reading fluency." They are also enjoying learning about nature." "I enjoy all Lend an Ear has to offer."

Survey results for youth participating in the Lend an EAR Reading Challenge. The demographics were as follows: [n=43] Gender: Male (51%), Female (49%); Race: Black (85%), White (5%), Other (10%); Ethnic Background: Hispanic (14%) or Non-Hispanic (86%). Grade: 4th (44%), 3rd (22%), 2nd (21%), 5th (13%).

The results were as follows:

- 93% wanted to read more because of the Lend an EAR Reading Challenge.
- 98% felt the Reading Challenge increased their knowledge of natural resource topics.
- 95% felt using Nearpod made the Reading Challenge more interesting.
- 95% felt the books encouraged them to protect the environment.
- Youth Comments: "I liked the questions!" I liked the stories; they were fun!" "I liked reading books I might not have read on my own."

The results for the collaborative At Home Beekeeping Series were as follows:

- 11 sessions were offered, totaling 2,624 live participants.
- Video content received a total of 44,625 minutes.
- It showcased speakers and moderators from 7 universities and 2 USDAARS facilities.
- An average savings of \$56 per person per session.

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

Overall, the activities provided educational information that promoted environmental awareness and improved knowledge. It offered opportunities for the broader public that accentuated the need for enhanced stewardship by everyone. Significant knowledge gains were observed for issues ranging from water quality to natural resources. Participants increased their ecological literacy and interest in the outdoors. Advances were also made in areas like disaster preparedness and climate resiliency, encouraging participants to reduce their ecological footprint. Finally, school-aged youth enhanced their performance skills: [i.e., ability to problem solve, evaluate, reason, focus, observe, research a problem, and measure (PERFORM)] and most importantly, their ability to read.

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

Several county staff voluntarily separated from the university to pursue relocation with family and other opportunities. These changes in staffing from a team of six to a team of three significantly affected the number of activities implemented via UESEP and the outputs and outcomes achieved in FY 2022. The team consisted of one State Specialist and two Urban Regional Extension Agents on a 50% split appointment. The hiring process to fill the vacancies is ongoing and should be completed in the upcoming year.

Urban Green

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002396



Urban Green (ANNUAL)

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

The phenomenon known as Urban 'Sprawl' has been a potential source of environmental hazards, water contamination and waste, and space management issues that contribute to the overall problem of environmental protection and sustainability of our natural resources. This sustainability trend has led to the demand for accessible information, educational programs, and training to address the increasing popularity of sustainable urban gardens and landscapes.

Target Audience: Total number reached by the Urban Home Grounds, Gardens and Home Pests Programming FY2022 was 49,057 (16,901 direct contacts and 32,156 indirect contacts); Urban Green FY2022 reached 9,725 individuals through 177 scheduled activities. Urban Green accounted for 50% (n=9,725) of total Urban Home Grounds programming. Urban Green participants were 77% (n=7,384) adults, 21% (n=2,073) youth, 34% (n=3,333) black, 61% (n=5,949) white, 33% (n=3,178) male, and 65% (n=6,317) female.

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 program's goals and objectives were accomplished with 177 activities implemented during FY2022. Most activities were hybrid workshops, demonstrations via mobile classroom, and online Back 2 Basics Wednesdays training sessions. Other activities included educational resource distributions, participation and demonstrations at county water festivals, county earth day events, tv interviews, radio interviews, social media posts, newsletter articles, flyers, newspaper articles, and extension blogs. Hybrid workshops and online sessions were used to help participating clientele learn more about various conservation practices used to help urban clientele with better managing and conserving natural resources. Comparison of the pretest and post-test scores indicated a significant percentage change or increase in participants' knowledge or understanding of the following:

Water Conservation (n = 7,158):

- Knowing the importance of water availability (67% increase)
- Knowing the impact of irrigation systems on water conservation (71% increase)
- Learning at least four ways to conserve water in the landscape (74% increase)
- Learning the significance of water runoff (56% increase)
- Learning the importance of rainwater collection (88% increase)

- Learning the importance, and how to compost (92% increase)

The average score for the clientele's overall knowledge of sustainable landscapes and how to conserve water increased by 75%.

BMPs for Sustainable Landscapes (n = 7,158):

- Know the importance and use of BMPs (56% increase)
- Know the importance of composting (92% increase)
- Know the methods of weed control (73% increase)
- How to use cultivation practices to control weeds (85% increase)
- How to use timers and drip irrigation (71% increase)
- How to use plasticulture as a management practice (47% increase)

The average score for the clientele's overall knowledge of BMPs increased by 71%.

IPM for Sustainable Landscapes (n = 7,158):

- Know the importance and use of IPMs (67% increase)
- Know what Integrated Pest Management involves (84% increase)
- Know the importance of beneficial insects (92% increase)
- The importance of using trap plants/crops (87% increase)
- Identify at least three beneficial insects (92% increase)
- How to use trap crops in field plantings (87% increase)

The average score for the clientele's overall knowledge of how to create a basic IP management plan increased by 85%.

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

The Urban Green workshops and added innovative demonstrations provided hands-on training and demonstrative support for urban clientele to adopt methods to that will help manage and conserve their urban natural resources. Approximately seven weeks after participating in our programs, clientele continued to use the information and skills gained from our programs.

Results from the delayed post-assessment were (n=2,703):

- Choosing the right plant for the right place (84%)
- Watering more efficiently using a timer (88%)
- Watering more efficiently using drip irrigation (79%)
- Inspecting for pests regularly (70%)
- Turning the compost pile regularly (82%)
- Purchased or built a rain barrel for use (66%)
- Purchased and planted a trap plant/crop (56%)

- Use weed fabric and much (80%)

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

Urban Green programs accounted for 50% (n=9,725) of total Urban Home Grounds programming in FY2022. Half of the participants in Urban Home Grounds programming were interested in learning about sustainable landscape and garden practices. This perfectly reflects the growing trend of individuals in urban areas being more cognizant of their environment and wanting to be better at natural resource conservation. These programs and the developed educational resources have increased urban clientele's ability to take an active part in maintaining a healthy environment and a clean supply of natural resources.

Urban Green: STEM in the Gardens

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002398



STEM in the Gardens (ANNUAL)

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

During the Covid-19 crisis, metropolitan areas across the nation have experienced an increased interest in their food source and security. As a result, the trend for increasing Urban Agriculture has gained momentum in urban schools. Unfortunately, urban school system teachers lack the background and training to promote, undertake, and successfully sustain a school garden while supporting STEM programs or to encourage urban agriculture. This program includes training for teachers on basic gardening principles and ways to align the Alabama gardening calendar with a school year calendar. It also includes solutions to common problems associated with outdoor classrooms.

Target Audience: In FY2022, the STEM in the Gardens program reached 407 individuals through 16 scheduled activities. STEM in the Gardens accounted for 0.2% (n=407) of total Urban Home Grounds programming. Urban Gardens participants were 100% adults (n=407), 0% youth (n=0), 19% black (n=77), 55% white (n=224), 20% male (n=83), and 59% female (n=239).

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 program's goals and objectives were accomplished with 16 activities implemented during FY2022. Class Sessions were hybrid workshops conducted online via Zoom. Other activities included educational resource distributions, tv interviews, radio interviews, social media posts, newsletter articles, flyers, newspaper articles, and extension blogs. Hybrid workshops were used to help the participating K-12 science teachers learn more about our nation's Agriculture Industry, starting, maintaining, sustaining, and integrating science lessons into a school garden/outdoor classroom. The programming and developed educational resources were used to help science teachers with starting and managing a school garden or outdoor classroom. Comparison of the pretest and posttest scores indicated a significant percentage change or increase in participants' knowledge or understanding of the following:

School Gardening (n = 407):

- Understanding the planting calendar relative to the school year (92% increase)
- Understanding the significance and importance of the Agriculture Industry (88% increase)
- Learning at least four ways to conserve water in the garden (88% increase)
- Learning the significance and science of a soil test (82% increase)

- Learning the science of plant nutrition (89% increase)
- Learning the science of soil (91% increase)

The average score for the clientele's overall knowledge of Stem in the Gardens and the Agriculture Industry increased by 88%.

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

The STEM in the Gardens Train the Teacher workshops and the added innovations provided support to STEM programming teaching methods using research-based applied modern agriculture methods and best urban agriculture management practices (Urban Ag BMPs). This teacher training program has utilized accepted STEM curricula to introduce agriculture-related careers to students and the great importance of agriculture in everyday society. As a result, the participants were more inclined and confident to initiate a school garden to supplement and support STEM teaching in their classrooms. In addition, participants were introduced to various potential Agriculture related career paths for their students to explore with STEM education. Approximately seven weeks after participating in our programs, teachers continued to use the information and skills gained from our programs in their school gardens.

Results from the delayed post-assessment were (n=407)

- Choosing the location for a garden (92%)
- Watering more efficiently using a timer (87%)
- Watering more efficiently using drip irrigation (84%)
- Scouting for pests regularly (93%)
- Conducting a soil test regularly (67%)
- Talked with their students about Agriculture and potential Careers (89%)
- Added ethnic-specific vegetables to their gardens (54%)
- Adopted plasticulture and irrigation (63%)

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

The Stem in the Garden Teach the Teacher program was offered twice a week over three-week period between the months of June and July during the FY2022. While the Stem in the Garden programming numbers only account for 0.2% (n=407) of the program team's total programming during 2022, the broader public benefited from the program outputs in the following ways:

- Increasing clientele's ability to sustain a school garden while providing knowledge and a newfound appreciation of students with the source of their food, growing their own food, and how the Agriculture Industry touches their lives every day.
- Learning about food insecurity, food deserts, and the challenges of obtaining fresh produce in urban areas.
- Introduction of potential careers within the Agriculture Industry to adults and youth in urban areas.
- These programs and the developed educational resources have increased urban clientele's ability to take an active part in growing their own food while potentially assisting in providing for limited-resource individuals and communities.

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.

Additional support has been provided through a USDA-NIFA Capacity Building Grant award for FY2022-2025.



Using ecological approaches to study the effects of dams on aquatic species

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

Dams can have profound effects on fishes that live both above and below them. In this project, we will look at how dams affect fishes, including by blocking their migration pathways along a river, and by changing the water flow and temperature patterns in the downstream river reaches. We will use a unique combination of sampling of fishes in the field, tagging and tracking fish locations and movement patterns, innovative micro-chemical analyses of fish ear stones (otoliths), and analyzing their genetics. Results from this work will be used to better predict the overall effects of these dams, and will provide valuable data for use as resource managers begin to look at ways to reduce any negative effects of dams.

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.

Relative to our study of the effects of dams on fishes, we worked in the lab and field to quantify ways in which dams affect fishes in large rivers. In the Alabama River, we tagged and translocated 20 migrating paddlefish upstream past Millers Ferry Lock and Dam (MFLD) in Wilcox County, AL to determine whether they would continue their upstream migration despite being moved from a turbulent lotic environment to a more lentic reservoir environment. We collected fish with gillnets in the tailrace of the dam in early March before spawning and transported them upstream of the dam in an aerated live-hauling tank on a truck. We then tracked them both actively and passively throughout the year, determining that most of them did continue their migration upstream, some even swimming all the way up to the next upstream dam (R.F. Henry). In late April, most of the fish were detected moving back downstream of MFLD. The exact route (through the spillway gates or through the powerhouse turbines) was not determined and remains a subject for further inquiry.

Within the reservoir that is impounded by MFLD, we sought to identify factors potentially contributing to seasonal paddlefish movement and habitat use and determine whether any passage of fish out of the reservoir occurs via the upstream (R.F. Henry Lock and Dam) and/or downstream (MFLD) dams. We tagged 23 paddlefish with combined acoustic/radio tags containing pressure and temperature sensors and released them in the reservoir. These fish were then tracked along the reservoir and in the Cahaba River both actively and passively. We also collected zooplankton samples in both the main channel and randomly selected backwater sites to quantify food availability in those habitats.

And in the area downstream of Claiborne Lock and Dam, we are studying the extent and effects of damage to the paddlefish rostrum, given the extent of this phenomenon in that area (which can include relatively minor damage to the rostrum being completely severed off). The rostrum of a paddlefish aids in detecting zooplankton prey and provides lift and stability in the water column, making it important to these individuals. Such non-lethal injuries may affect fish body condition and swimming ability. We collected and tagged paddlefish downstream of Claiborne Lock and Dam using gillnets and tracked their movements throughout the Alabama River and across all three lock and dam structures. These data will be used to determine whether rostrum damage affect movement, passage, and ultimately their long-distance migrations. We also plan to create a paddlefish model to quantify the hydrodynamic effects of varying levels of rostrum damage. Preliminary results suggest that both male and female Paddlefish with rostrum damage had lower body condition than those without rostrum damage. However, there was no difference in passage rate at Claiborne Lock and Dam between Paddlefish with rostrum damage versus without, and rostrum damage score did not appear to differ between fish that passed versus did not pass.

In the US Army Corps of Engineers/ERDC lab in Vicksburg, Mississippi, we completed 15 swimming trials of bighead carp surgically implanted with accelerometer tags in an effort to quantify fish response to a variable flow field created by inserting a D-shaped cylinder. This work was followed by additional swim trials in a smaller, enclosed system where we quantified oxygen consumption and recorded behavior in order to correlate swimming speed with accelerometer tag data.

Finally, in our work in the Tallapoosa River, we conducted 14 respirometry trials that completed our Tallapoosa River resting metabolic rate study. We also completed an intensive laboratory project where we measured resting metabolic rate of largemouth bass at 9 acclimation temperatures, followed by enzymatic tissue analysis in an effort to establish enzyme analysis as a potentially non-lethal and quick method for measuring fish thermal tolerance. This included testing multiple

tissue types in order to determine whether any differences existed across tissue types for determining such tolerance. Finally, these data were used to create a resting respiration to enzyme activity ratio.

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

--We have made numerous presentations of our findings to stakeholders, including resource agencies in Alabama, personnel with the U.S. Army

Corps of Engineers (who are funding the bulk of this work concerning the influence of dams on fish in riverine systems), and personnel and stakeholders with the Alabama Power Company.

--We and our graduate students have made a number of presentations at international, national, regional, state, and local professional scientific meetings.

--We continue to participate in a joint feasibility study between the U.S. Army Corps of Engineers and The Nature Conservancy to determine whether fish bypass structures can or should be constructed at the lowermost two lock-and-dam structures on the Alabama River. We have participated as biological and ecological experts in this process, and data that are being produced by this work are being used to support the joint feasibility study process.

--Based on our data and modeling efforts, we have just recently been asked to participate in a working group of the U.S. Army Corps of Engineers and the U.S. Geological Survey relative to model development for fish passage on the Mississippi River system.

Publications:

Horne, L., D.R. DeVries, R. Wright, E. Irwin, B. Staton, H. Abdelrahman, and J. Stoeckel. in press. Thermal performance of the electron transport system Complex III in seven Alabama fishes. *Journal of Experimental Zoology Part A* (26 text pages, 2 tables, 3 figures).

Horne, L., D.R. DeVries, and J. Stoeckel. in press. The effects of glochidia infection on the metabolic rate and hypoxia tolerance of bluegill *Lepomis macrochirus* and largemouth bass *Micropterus salmoides*. *Journal of Parasitology* (23 text pages, 4 tables, 2 figures).

Grove, L., E.G. Stell, L.J.W. Grove, R.A. Wright, and D.R. DeVries. 2022. Influence of blueback herring, *Alosa aestivalis*, on zooplankton in a Southeastern US reservoir. *Lake and Reservoir Management* 38:256-267.
<https://doi.org/10.1080/10402381.2022.2072418>.

Carlson, A.K., W.W. Taylor, D.R. DeVries, C.P. Ferreri, M.J. Fogarty, K.J. Hartman, D.M. Infante, M.T. Kinnison, S.A. Levin, R.T. Melstrom, R.M. Newman, M.L. Pinsky, D.I. Rubenstein, S. Mažeika, P. Sullivan, P.A. Venturelli, M.J. Weber, M.R. Wuellner, and G.B. Zydlewski. 2022. Stepping up: a U.S. perspective on the ten steps to responsible inland fisheries. *Fisheries* 47:68-77.
<https://doi.org/10.1002/fsh.10695>.

Hershey, H.J., D.R. DeVries, R.A. Wright, and D. McKee. 2022. Evaluating fish passage and tailrace space use at a low-use low-head lock-and-dam. *Transactions of the American Fisheries Society* 151:50-71. <https://doi.org/10.1002/tafs.10330>.

Rotar, C.L. 2022. Evaluating the effects of three Alabama River dams on fish movements and population connectivity using otolith microchemistry. M.S. thesis, Auburn University, AL. 119 pages.

Presentations:

DeVries, D.R., and R.A. Wright. 2021. Considering questions of scale in research: examples from lotic, lentic, and coastal systems. Annual Meeting of the American Fisheries Society, Baltimore, MD.

Hershey, H., D.R. DeVries, R.A. Wright, D. McKee, and D.L. Smith. 2021. Evaluating fish passage and tailrace space use at a low-use low-head lock-and-dam. Annual Meeting of the American Fisheries Society, Baltimore, MD.

Horne, L.M., D.R. DeVries, and J.A. Stoeckel. 2021. Effects of ecologically relevant levels of glochidia infestation on metabolic rate and hypoxia tolerance of Bluegill *Lepomis macrochirus* and Largemouth Bass *Micropterus salmoides*. Annual Meeting of the American Fisheries Society, Baltimore, MD.

Lamb, E., D.R. DeVries, and R.A. Wright. 2021. Can otolith microchemistry be used to quantify fish movement downstream of a hydropeaking dam? Annual Meeting of the American Fisheries Society, Baltimore, MD.

Rotar, C., D.R. DeVries, and R.A. Wright. 2021. Evaluating fish movements and identifying potential dam passages within the Alabama River system using otolith microchemistry techniques. Annual Meeting of the American Fisheries Society, Baltimore, MD.

Stell, E., G.L. Grove, R.A. Wright, and D.R. DeVries. 2021. Influence of Blueback Herring, *Alosa aestivalis*, in a Reservoir. Annual Meeting of the American Fisheries Society, Baltimore, MD.

Stell, E., D.R. DeVries, and R.A. Wright. 2021. Swimming performance and metabolism of four fish species under the flow and temperature regimes of a regulated river. Annual Meeting of the American Fisheries Society, Baltimore, MD.

Colvin, S.R., R.A. Wright, D.R. DeVries, and J.W. Feminella. 2021. Are weight-length parameters of coastal Alabama stream fishes linked with life history traits and environmental variables? Annual Meeting of the Southeastern Fishes Council, Columbus, GA.

Birdsall, B.D., S.K. Brewer, and D.R. DeVries. 2022. Comparing ageing structures of Bighead Carp *Hypophthalmichthys nobilis* and Silver Carp *Hypophthalmichthys molitrix*. Annual Meeting of the Southern Division of the American Fisheries Society, Charleston, SC.

Ramsey, P., S.K. Brewer, and D.R. DeVries. 2022. Factors related to successful spawning of riverine Spotted Bass *Micropterus punctulatus* in the lower Red River basin. Annual Meeting of the Southern Division of the American Fisheries Society, Charleston, SC.

Stell, E., D.R. DeVries, and R.A. Wright. 2022. Resting metabolic rate and hypoxia tolerance of four fish species in the Tallapoosa River. Annual Meeting of the Southern Division of the American Fisheries Society, Charleston, SC.

Rotar, C., D.R. DeVries, and R.A. Wright. 2022. Evaluating fish movements and identifying potential dam passages within the Alabama River system using otolith microchemistry techniques. Annual Meeting of the Southern Division of the American Fisheries Society, Charleston, SC.

Lamb, E., D.R. DeVries, and R.A. Wright. 2022. Fish communities and diets in the Tallapoosa River upstream and downstream of a peaking hydropower facility. Annual Meeting of the Southern Division of the American Fisheries Society, Charleston, SC.

Hershey, H., A. Stanfill, D.R. DeVries, R.A. Wright, W. Patterson, and J. Lewis. 2022. Quantifying differences in three potential contingents of Southern Flounder from the Northern Gulf of Mexico using otolith microchemistry. NOAA/Gulf States Marine Fisheries Commission Flounder Symposium, Baton Rouge, LA.

Hitchman, S., M.E. Mather, J.M. Smith, K.L. Pope, D.R. DeVries, M.P. Carey, and J.E. Garvey. 2022. Direction and progress for impactful science-based conservation. Joint Aquatic Sciences Meeting, Grand Rapids, MI (virtual).

Pope, K.L., M.P. Carey, D.R. DeVries, J.E. Garvey, M. Henderson, S. Hitchman, M.E. Mather, J.M. Smith, R.W. Tingley. 2022. Researchers and managers: co-development of science-based management. Joint Aquatic Sciences Meeting, Grand Rapids, MI (virtual).

DeVries, D.R., M.P. Carey, J.E. Garvey, S. Hitchman, M.E. Mather, K. Pope, J.M. Smith, and R.W. Tingley. 2022. Connecting biology to policy: linking scales for data collection to scales needed for the decision-making process. Joint Aquatic Sciences Meeting, Grand Rapids, MI (virtual).

Bickley, S.L., C. Anderson, S. Isik, L. Kalin, and D.R. DeVries. 2022. Coastal development causes change in tidal creek ecosystem structure and function. Joint Aquatic Sciences Meeting, Grand Rapids, MI (virtual).

Hershey, H., A. Stanfill, D. R. DeVries, R. Wright, W. Patterson, and J. Lewis. 2022. Quantifying differences in three potential contingents of Southern Flounder from the Northern Gulf of Mexico using otolith microchemistry. Annual Meeting of the American Fisheries Society, Spokane, WA.

Hershey, H., D. R. DeVries, and R. Wright. 2022. Simulating fish passage impacts on American Paddlefish metapopulation dynamics. Annual Meeting of the American Fisheries Society, Spokane, WA.

Stell, E., D. R. DeVries, and R. Wright. 2022. Resting metabolic rate and hypoxia tolerance of four fish species in the Tallapoosa River. Annual Meeting of the American Fisheries Society, Spokane, WA.

Colvin, S., B. Helms, D. DeVries, and J. Feminella. 2022. Investigating theoretical predictions of patterns in lotic fish assemblages. Annual Meeting of the American Fisheries Society, Spokane, WA.

Hershey, H., D. R. DeVries, and R. Wright. 2022. Simulating fish passage impacts on American Paddlefish metapopulation dynamics. Annual Meeting of the North American Sturgeon and Paddlefish Society, Folsom, CA.

Hershey, H., D. R. DeVries, and R. Wright. 2022. Retracing pre-impoundment fish migrations in the Mobile Basin, Alabama. Annual Meeting of the Southeastern Fishes Council, Athens, GA.

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

Data being produced from our research are providing critically needed information relative to the behavior of fishes in a large river system such that decisions can be made about the operations of lock-and-dam structures, hydropower operations, and flood gate structures, while maintaining for human use of the river for navigation and recreation.

Closing Out (end date 03/06/2024)

Implications of Shifting Water Availability on Temperate Forest Productivity

Project Director

Dawn Lemke

Organization

Alabama A&M University

Accession Number

1024525



Implications of Shifting Water Availability on Temperate Forest Productivity

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

This project aims to conduct applied research focusing on broadening the available knowledge base on the long-term impacts of changing water availability related to forest ecosystems' net primary productivity (NPP). With the principal goal of greater sustainable management and resilience of agroecosystems, this project proposes applied research by a multidisciplinary and collaborative team, active dissemination of information to those outside the direct research field in addition to the contribution to scientific literature, and the development of a diverse future workforce with skill in data analytics, project management, and decision making. The research objectives focus on evaluating shifts in forested ecosystem productivity across various temporal (past, current, and future) and spatial (micro: plot; macro: watershed/regional) scales. By developing large-scale models of where the most significant shifts in NPP occur, we, as a country and a society, will be better placed to identify adaptive management strategies to safeguard our society, economy, and environment.

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

1. Graduate student was engaged in sensor installation to assist in data collection for plot scale work and to develop a research proposal.
2. Through a collaboration with the University of Maine, MS State, and UAH, we have been developing networked soil moisture (one measure of water availability) sensors that will increase spatial and temporal resolution at a low cost.

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

Several graduate and undergraduate students were involved in this project; they participated in geospatial training, data analytics, and project development.

Partnerships with regional state and federal agencies continued to allow site sampling and facilitated conversations about broader research and the dissemination of results.

Further partnership development with research programs at other universities has led to solid progress in plot scale sensor development work

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

Limited results are available at this stage, and presentations are planned over the next year. The majority of dissemination has been through interaction with partners and building relationships.

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.

- 1) Extending the completion time for the research, due to delayed recruitment of graduate students and higher workloads for faculty, due to Covid, research has not progressed as fast as expected.
- 2) A slight shift to focus on plot and landscape approaches outside of the two sampled sites is expected due to a change in PI health and limitation on field-based work.

Closing Out (end date 03/06/2024)

Ecology and management of pests attacking turfgrass and ornamentals in Alabama

Project Director

David Held

Organization

Auburn University

Accession Number

1022289



Ecology and management of pests attacking turfgrass and ornamentals in Alabama

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

This project address concerns with biodiversity declines in urban areas associated with urbanization or the use of insecticides or other chemicals for plant growth or protection. Urbanization (habitat changes) produces landscapes that have low plant diversity which then impacts outbreaks of herbivorous insects. Pesticides are powerful tools to manage pest outbreaks but can have negative impacts on biodiversity even when used judiciously and according to the label.

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

For Objective 1, a collaboration with another lab at Auburn University evaluated and published a research paper on the methodologies developed with fall armyworms and nanoparticles. Results from the research on fall armyworms suggests that the cellular uptake of dsRNA (endocytosis) is clathrin-mediated, and this is largely responsible for cellular uptake of dsRNA. Once inside the midgut, transcytosis is involved in shuttling BAPCs from the lumen to the hemolymph. This opens up further possibilities for BAPCs as a new insect pest management method. In work with Japanese beetles (*Popillia japonica*), we evaluated the fate of a candidate dsRNA for gene silencing when ingested by either adult or immature (white grubs) Japanese beetles (*Popillia japonica*). The candidate dsRNA was evaluated alone or in a complex with a type of nanoparticle called branched amphiphilic peptide capsules (BAPCs). BAPCs helped to increase uptake of the candidate dsRNA in white grubs and increase the efficacy of gene knockdown relative to dsRNA alone in *P. japonica* adults. To our knowledge, this is the first report on dsRNA nanoparticle-mediated delivery through feeding in *P. japonica*. This work is in preparation for submission for publication.

For Objective 2, we are still focused on crape myrtle bark scale as infestations continue to spread in Alabama and nationally. Crape myrtle bark scale is an exotic scale insect outbreaking in landscapes. Where it outbreaks, insecticides are one of the only ways to prevent damage. We conducted two experiments; one greenhouse and one landscape trial, that built upon our previous results demonstrating the effectiveness of limonene to prevent and treat infestations of CMBS. The greenhouse experiment, conducted over a 2 month period, compared limonene applied weekly to the efficacy of three insecticides, two systemic (imidacloprid and dinotefuran) and one insect growth regulator (pyriproxyfen) used for CMBS control. By week 4 and thereafter, plants treated with limonene had 90% or greater reduction in CMBS populations (<35 CMBS per sample) relative to

before treatment. For reference, there were 58 to 73% reductions for the insecticides commonly used for CMBS control over the 2 month greenhouse experiment. Infested trees in the landscape were also used to evaluate whole plant limonene applications and conservation biological control of CMBS. This study identified that either solutions of limonene (orange oil) or yellow panels that attract natural enemies were equally or more effective as systemic insecticides to control crape myrtle bark scale. Interestingly, the combination of these two interventions did not reduce populations relative to control trees. Also for Objective 2, we published a paper summarizing the previous field research on reduced-risk insecticides for managing fall armyworm, *Spodoptera frugiperda*, in turfgrass. Fall armyworm is an important pest of turfgrass and food crops. Insecticides such as diamides provide longer residual control of some grass-feeding caterpillars relative to pyrethroids. The objective was to compare the responses of fall armyworm larvae to residues of commonly used insecticides on hybrid bermudagrass (*Cynodon dactylon* (L.) x *C. transvaalensis* Burt-Davy). A field experiment determined mortality of free-ranging fall armyworms exposed for 1-3 hours on turfgrass at 1, 7, 14, 28, and 42 days after a foliar application. A laboratory experiment determined the mortality of larvae fed grass clippings harvested from treated plots at 1, 3, 7, 14, 28, and 42 days after application. Larvae crawled similar or greater distances across bermudagrass treated with bifenthrin and permethrin relative to non-treated grasses. After crawling on bermudagrass treated with chlorantraniliprole or cyantraniliprole 14 days after application, larval mortality was $\geq 77\%$. Mortality of larvae fed pyrethroid-treated clippings was $\leq 40\%$ and no different from control larvae regardless of residue age. Larvae fed bermudagrass with 1 to 7 day old residues of cyantraniliprole or indoxacarb resulted in significantly greater mortality than larvae fed non-treated clippings. No residues of cyantraniliprole or indoxacarb older than 7 day resulted in mortality significantly greater than larvae fed non-treated clippings. Larvae fed chlorantraniliprole-treated clippings of all residue ages produced larval mortality greater than larvae fed non-treated clippings. These experiments support previous reports of extended residual control from chlorantraniliprole against other grass-feeding caterpillar species. The diamides protect turfgrass from larvae better than pyrethroids.

For Objective 3, we concluded data analysis and manuscript preparation for field research conducted in 2021. A manuscript was drafted and submitted for publication. In summary, a two-year study conducted in bermudagrass hay fields in central Alabama evaluated the potential of two plant growth-promoting rhizobacteria (PGPR) treatments for sustainable grass management. The two PGPR treatments were applied with and without lowered rates of nitrogen and compared to a full rate of nitrogen fertilizer in a hay production system. Over a 2 year period, we collected data on forage biomass, forage quality, arthropod populations, soil mesofauna populations, and soil microbial respiration. Applications of PGPR with a half rate of fertilizer yielded similar forage biomass and quality results as that of a full rate of nitrogen. All PGPR treatments increased soil respiration over time. The results of this study indicated promising potential for PGPR applied with lowered nitrogen rates to reduce chemical inputs while maintaining yield and quality of forage.

Publications

Refereed

Carroll, E., K. Carson, D.W. Held. 2022. Residues and Routes of Exposure of Insecticides in Turfgrass for Control of Fall Armyworm Larvae (Lepidoptera: Noctuidae). *J. Entomological Science* 57:182-193.

de Souza, I. G. P., E. B. de Castro, E. B., G. M. Henry, D. W. Held, J.G. Hill, J. D. McCurdy. 2022. Evaluation of flower visiting insects specimen sampling methodology in turfgrass-forb habitat. *International Turfgrass Society Research Journal* 14:1026–1029.

McGraw, E., J. D. Roberts, N. Kunte, M. Westerfield, X. Streety, D. Held, and L.A. Avila. 2022. Insight into Cellular Uptake and Transcytosis of Peptide Nanoparticles in *Spodoptera frugiperda* Cells and Isolated Midgut. *ACS Omega* 7: 10933-10943.

Non-referred Technical reports

Clem, S.C., K. Kesheimer, and D.W. Held. 2021. Outbreaks of the broad-headed bug *Esperanza texana*. *Turftimes* Winter 2022 (Alabama Turfgrass Association magazine, published Nov 2021).

Vinson, A., E. Carroll, and D. Held. 2022. Controlling Crape Myrtle Bark Scale & Conserving Beneficials. *Turftimes* Summer 2022 (Alabama Turfgrass Association magazine, published Aug 2022).

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

The results of this project were disseminated to target audiences through 23 presentations, 5 publications, and social media. Of these, 17 presentations and 2 publications were delivered to nursery, turf, urban forest and landscape managers, and 6 were delivered at professional scientific meetings. As part of this project year, we created a postcard resource with the support

of the Southern Region Pest Management Center. This full color resource helps users to correctly and accurately identify CMBS and the life stages of the common lady beetles that help to reduce their abundance.

Our research was featured on one podcast and a student working on this project created a blog highlighting her on-going research. In response to 13 tweets related to the project, there were 7459 impressions, 252 engagements, 16 re-tweets, 63 likes, 16 link clicks, and three tweeted videos generated 381 video views.

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

Work on this project continues to research and identify ways to reduce chemical inputs into urban landscapes. For turfgrass insects, our published paper this year showed how a few lower toxicity insecticides can alleviate the need for more frequent applications of older generation insecticides for control of fall armyworm. For Japanese beetles, we had a major breakthrough demonstrating uptake and movement of dsRNA aided by peptide nanoparticles. This provides the groundwork for target specific control of this pest particularly in areas where insecticide use is heavy or where it is still considered a regulated pest (OR, CA). Regulatory uses of non-specific insecticides can be excessive to eradicate this pest locally. For crape myrtle bark scale, our projects with limonene continue to provide promising results that systemic insecticides, which can place bees and beneficial flower visiting insects at risk, are less necessary for management of this important pest in southern landscapes.

Study abiotic stress tolerance in cotton and peanut: implementation of high-throughput phenotyping techniques

Project Director

ALVARO SANZ SAEZ DE JAUREGUI

Organization

Auburn University

Accession Number

1020718



Study abiotic stress tolerance in cotton and peanut: implementation of high-throughput phenotyping techniques

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

1. Discover physiological traits responsible of drought tolerance in peanuts.
2. Study cotton evolution to understand nutrient acquisition and current fertilizer needs.
3. Use hyper-spectral reflectance technology to implement high-throughput phenotyping techniques to estimate relevant physiological traits.

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

1. Discover physiological traits responsible of drought tolerance in peanuts.

In order to be able to research drought stress with more precision we have built four plastic rainout shelters in Spring Summer 2022. In order to test its efficacy, we repeated the irrigation experiment conducted in 2021 with 9 drought tolerant and sensitive cultivars. To look how the rainout-shelters look, please watch this YouTube video where Dr. Sanz-Saez explain to Crop Physiology students (CSES7250) how this facility works and the impact for agriculture that this facility could have in the future <https://www.youtube.com/watch?v=TUrqngtNwFM>.

We also have performed measurements in this experiment to test if drought tolerant cultivars have deeper root system than drought sensitive ones. To do this we used a Giddings soil core excavator and measured how deep the roots of each cultivar reach in the soil. We found that all drought tolerant cultivars had deeper root systems than drought sensitive peanut cultivars.

In order to discover which are the genomic underpinnings of drought tolerance, we have measured the phenotypes of an F2 population crossed between a drought tolerant cultivar (Tif-runner) and a drought sensitive one. For this experiment we grew the plant in a rain-out shelter facility at the National Peanut Research Laboratory in Dawson, Georgia. We measured photosynthetic and yield components. We are now analyzing the data to understand the genomic mechanisms of drought tolerance.

2. Study cotton root evolution to understand nutrient acquisition and current fertilizer needs.

In 2019, 2020, and 2021 twenty cotton cultivars that span 60 years in their year of release (1953-2018), were planted in EV-Smith Research Station to study how breeding has impacted yield, yield components, root development and nutrient uptake. This last year we have been processing all the samples and preparing the data for several publications. In 2019 persistent drought that was not alleviated by irrigation, made the results very variable and therefore unusable and thus that year was eliminated of the analysis. We have found that lint yield has increased during the breeding process thanks to the increase in total biomass but with a continuous improvement of the lint HI. In fact thanks to path analysis we have found that the biggest driver in increasing lint yield is the increase in lint HI, therefore breeders should focus on increasing lint HI more than increasing biomass. Dr. Sanz-Saez's PhD student have presented this results in the American Society of Agronomy on November 2022 winning the first prize of the poster and oral presentation (See section below for presentation details).

Regarding nutrient uptake we have discovered that in 2020 and 2021, nutrient uptake increased in the newer cultivars compared with the old ones. This increase in nutrient uptake is due to higher biomass accumulation in newer cultivars that as explained above is responsible of the higher yields. However we have seen that newer cultivars do not have higher nutrient use efficiency as it has been seen in high yielding environments such as in Australia. This leaves room for breeders to improve nutrient use efficiency probably by better nutrient allocation to seeds and lint and better nutrient absorption by roots.

3. Use hyper-spectral reflectance technology to implement high-throughput phenotyping techniques to estimate relevant physiological traits.

One of the keys to improve crop yield under different stresses is by studying photosynthetic capacity. Photosynthetic parameters, such as the maximum rate of rubisco carboxylation and maximum rate of ribulose regeneration vary in response to climate conditions and between cultivars and have been identified as key targets for improvement. However, the main techniques used to measure these physiological parameters are very time consuming, taking between 20 to 60 minutes. In this objective, we studied which statistical models (PLSR, BR, ARDR and LASSO) are more accurate to estimate photosynthetic parameters using leaf hyperspectral reflectance data measured with a portable field spectrometer (ASD FieldSpec4 Hi-Res). In addition, we tested if combining information from different crops (soybean, cotton and peanut) increase the efficiency of the model to predict photosynthetic parameters. We found that combining crops increases the efficiency of all models as it increased the range of phenotypic variation.

In collaboration with University of Illinois at Urbana-Champaign, we have been able to use hyperspectral reflectance and PLSR models to predict complex photosynthetic traits such as Rubisco carboxylation maximum activity (V_{cmax}) in a NAM soybean population that comprises more than 2000 soybean lines. With this approach we have been able to perform QTL mapping for this photosynthetic traits which is something that never was done before. This published method (see in section before) will allow geneticist and breeders to find the genomic regions for higher photosynthesis in soybean (and we hope that in other crops) allowing for the selection of cultivars with higher photosynthesis and we hope higher yields.

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

We have distributed the information in peer review manuscripts, conference presentations and posters, invited lectures and talks (See list below) which will give information to the target audience of scientist, students, and growers.

To accomplish the objectives of this project, Dr. Sanz-Saez has trained 2 PhD and 1 Master student, and has received two international visiting scholars from Spain.

This year, Dr. Sanz-Saez has taught two course related with this Hatch Project, Crop Physiology (CSES 7250) and Principles of Plant Nutrition (CSES7540) in which Dr. Sanz-Saez uses information obtained in his field experiments to illustrate the effects of abiotic stress on row crops and how nutrition affect crops yield.

Peer reviewed manuscripts

1. Leisner CP, Potnis N, **Sanz-Saez A** (Accepted) Crosstalk and trade-offs: Plant responses to climate change-associated abiotic and biotic stresses. Plant, Cell & Environment.

2. Zhen X, Huo W, Tian D, Zhang Q, Chen CY, **Sanz-Saez A**, Dang PM, Batchelor WD (Accepted) **County level calibration strategy to evaluate peanut irrigation water use under different climate change scenarios.** European Journal of

3. Zhen X, Zhang Q, **Sanz-Saez A**, Chen CY, Dang PM, Batchelor WD (2022) Simulating drought tolerance of peanut varieties by maintaining photosynthesis under water deficit. *Field Crops Research* 287, 108650.
4. Zhang Q, Chen C, Feng Y, Batchelor W, Dang P, Lamb M, **Sanz-Saez A** (2022). Tolerance to mid-season drought in peanut can be achieved by high water use efficiency or high efficient use of water. *Crop Science*. Doi: 10.1002/csc2.20806
5. Montes CM, Fox C, **Sanz-Saez A**, Serbin SP, Kumagai E, Krause MD, Xavier A, Specht JE, Beavis WD, Bernacchi CJ, Diers BW, Ainsworth EA (2022). **High-throughput characterization, correlation, and mapping of leaf photosynthetic and functional traits in soybean (Glycine max) nested association mapping population.** *Genetics*, 221(2), doi.org/10.1093/genetics/iyac065
6. Buchailot ML, Soba D, Shu T, Liu J, Aranjuelo I, Araus JL, Runion B, Prior SA, Keufaver SC, **Sanz-Saez A** (2022). Estimating peanut and soybean photosynthetic traits using leaf spectral reflectance and advance regression models. *Planta*, 255:93. <https://doi.org/10.1007/s00425-022-03867-6>.

Conference Presentations

1. [Singh J](#), [Gamble A](#), [Koebernick J](#), [Brown S](#), **Sanz-Saez A**. How cotton nutrient efficiency, partitioning, and uptake changed over the past 70 years? Oral. 2022 Agronomy Society of America, Fiber Crop Community Student Competition. Baltimore, MA, November 6-9, 2022.
2. [Singh J](#), [Gamble A](#), [Koebernick J](#), [Brown S](#), **Sanz-Saez A**. Understanding the Changes in Cotton Biomass, Lint, and Yield Components Over the Past 70 Years. Poster. 2022 Agronomy Society of America, Fiber Crop Community Student Competition. Baltimore, MA, November 6-9, 2022.
3. Zhang Q, Chen C, Feng Y, Batchelor W, Dang P, Lamb M, **Sanz-Saez A**. Investigating Physiological Traits Responsible of Drought in F1 bi-parental Population Derived from the Crosses of Tif-runner with Drought Tolerant and Sensitive Cultivars. Oral. Crop Science Society of America, Crop Physiology and Metabolism Section. Baltimore, MA, November 6-9, 2022.
4. **Sanz-Saez A**, Dang P, Zhang Q, Feng Y, Batchelor W, Lamb M, Chen C. Using photosynthetic and isotopic techniques to identify different drought tolerant mechanisms in peanut. Oral. American Peanut Research and Education Society. July 12-14, 2022, Dallas, Texas.
5. Dang P, Lamb M, Chen C, **Sanz-Saez A**. Current Challenges in Peanut Breeding for Drought Tolerance and Future Prospects. Oral. American Peanut Research and Education Society. July 12-14, 2022, Dallas, Texas.
6. **Sanz-Saez A**, **Buchailot ML**, Soba D, Shu T, Prior S, Runion B, Liu J, Araus JL, Kefauver SC. Poster. Estimating plant photosynthetic traits using leaf spectral reflectance and advance regression models. Artificial Intelligence Applications in Agriculture Conference. April 14-17, 2022, Auburn, Alabama.
7. Zhang Q, Dang P, Chen C, Feng Y, Batchelor W, Lamb M, **Sanz-Saez A**. Poster. Discovering drought tolerant peanut genotypes with high water use efficiency and efficient use of water using different physiological techniques. Crops Conference. June 13-16, 2022, Hunstville, Alabama.

1. **Sanz-Saez A.** The hungry or thirsty dilemma and how can we select and manage row crops to obtain high yields and preserve water. Alabama Crop Management Association, Certified Crop Advisor Training. Auburn University, December 2022.
2. **Sanz-Saez A.** Screening for drought tolerant peanut cultivars, the Discovery of water user and water saver peanut cultivars. Southeast Alabama Farmers Irrigation Focus Group. Hartford, Alabama, August 2022.
3. **Sanz-Saez A.** The Role of Water Use Efficiency Genotypes on Crop Production and Relationship with Irrigation. Irrigation in Service Training for Extension Agents. EV-Smith Research Center, Shorter, March 2022
4. **Sanz-Saez A.** Using Field Physiology Techniques to Find Contrasting Mechanisms of Drought Tolerance in Peanut. Auburn University Water Seminar. February 2022.

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

We have published peer-reviewed papers and attended to scientific meeting to spread the information gathered in our experiments with the scientific community that is one of the main target audiences of this hatch project. In peanut we have proposed that there are two mechanisms of drought tolerance in peanut. These theories have been well accepted by physiologist and breeders.

In addition, peanut drought tolerance studies have been disseminated with extension agents, crop advisors and growers through invited talks in extension meetings. With these meetings we have made growers to understand to properly select for cultivars that may be drought tolerance and cultivars that can use less water and therefore be suited for growing under rain fed conditions and thus save water. We hope that this will decrease agricultural water use but increase or maintain yield which will benefit society widely.

Closing Out (end date 03/06/2024)

Quantification of Nutrient Transport Dynamics in Agricultural Landscapes

Project Director

Jasmeet Lamba

Organization

Auburn University

Accession Number

1019462



Quantification of Nutrient Transport Dynamics in Agricultural Landscapes

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

Improving our knowledge of fundamental processes controlling the fate and transport of contaminants in soils is a prerequisite to developing appropriate nutrient management strategies, decision support tools and models. The focus of this proposal is to determine the effect of watershed characteristics on the flux, fate and transport of various contaminants (e.g., metals, sediment, nutrients) in agricultural landscapes.

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

We characterized soil physical and chemical properties to quantify the impact of these properties on nutrient transport dynamics. Further, we performed temporal disaggregation of hourly precipitation in the southeast US to enhance our understanding of climate change on nutrient transport processes. The high-resolution data would enable us to accurately

elucidate nutrient transport processes at a watershed scale. Rainfall simulation experiments were conducted to quantify the nutrient loss in leachate. Additionally, the impact of precision irrigation approaches on nutrient transport dynamics was investigated.

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

New knowledge was generated on the role of soil macropore characteristics and precision irrigation approaches on nutrient dynamics. Further high resolution precipitation data generated for southeast US would assist in various modeling and field investigations.

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

The project activities resulted in the generation of new knowledge in non-point source pollution management, which would help develop management strategies in agricultural watersheds. The high-resolution precipitation data would assist in climate change studies in the field of hydrology. Further, development of management practices in areas used extensively for livestock production would enhance sustainability of agricultural operations and benefit producers.

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

Five graduate students conducted research as a part of this project. Results were disseminated via conference presentations and peer-reviewed publications. We will perform modeling studies to better understand nutrient transport processes in soil columns. Additional soil samples will be collected from different land uses to perform column-based rainfall simulation experiments. We will test different soil amendments to quantify their effectiveness in improving agricultural water quality. The publications generated from this project are listed below:

1. Kumar, H., P. Srivastava, J. Lamba, B.V. Ortiz, T.R. Way, L. Sangha, B. Takhellambam, G. Morata, and R. Molinari. 2022. Within-field variability in nutrients for site-specific agricultural management in irrigated cornfield. *Journal of the ASABE*. 65(4):865-880. <https://doi.org/10.13031/ja.15042>.
2. Kumar, H., P. Srivastava, J. Lamba, E. Diamantopoulos, B. Ortiz, G. Morata. B. Takhellambam, and L. Bondesan. 2022. Site-Specific Irrigation Scheduling Using One-Layer Soil Hydraulic Properties and Inverse Modeling. *Agricultural Water Management*. 273: 107877. doi:<https://doi.org/10.1016/j.agwat.2022.107877>.
3. Takhellambam, B.S., P. Srivastava, J. Lamba, R.P. McGehee, H. Kumar and D. Tian. 2022. Temporal disaggregation of hourly precipitation under changing climate over the Southeast United States. *Scientific Data* 9: 211. doi:10.1038/s41597-022-01304-7.
4. Budhathoki, S., J. Lamba, P. Srivastava, C. Williams, F. Arriaga and K.G. Karthikeyan. 2022. Impact of land use and tillage practice on soil macropore characteristics inferred from X-ray computed tomography. *CATENA* 210: 105886. doi:<https://doi.org/10.1016/j.catena.2021.105886>.
5. Budhathoki, S., J. Lamba, P. Srivastava, K. Malhotra, T.R. Way, and S. Katuwal. 2022. Temporal and Spatial Variability in 3D Soil Macropore Characteristics Determined Using X-ray Computed Tomography. *Journal of Soils and Sediments*. <https://doi.org/10.1007/s11368-022-03150-x>
6. Budhathoki, S., J. Lamba, P. Srivastava, K. Malhotra, S. Katuwal, and T. R. Way. 2022. Using X-ray Computed Tomography to Quantify Variability in Soil Macropore Characteristics in Pastures. *Soil and Tillage Research*. 215: 105194. doi:<https://doi.org/10.1016/j.still.2021.105194>.

Leveraging genomics-enabled plant physiology to understand crop nutritional and quality losses caused by climate change

Project Director

Courtney Leisner

Organization

Auburn University

Accession Number

1018601

**Leveraging genomics-enabled plant physiology to understand crop nutritional and quality losses caused by climate change****In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

While much work has been done to investigate the projected effects of climate change on cereal and seed crop production, less work has focused on the projected effects of climate change on market and nutritional quality in non-cereal, large acreage crops or perennial cropping systems. The overall goal of this Hatch project is to use genomics-enabled plant physiology to understand nutritional and quality losses of fruit and vegetables to climate change, with a focus on potato, blueberries, soybean, and pepper. Outcomes from this project will link complex physiological phenotypes associated with plant production, quality, and nutritional losses with their underlying biochemical and genetic mechanisms to engineer a sustainable future food supply considering global climate change.

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.

Blueberry. We are elucidating the genes responsible for natural product biosynthesis in blueberry using comparative genomic approaches, as well as metabolites in blueberry that contribute to flavor and fruit quality. By combining physiology, metabolite, and transcriptomic data for biosynthetic gene identification, I have developed a platform for determining the physiological and ecological function of natural product biosynthesis in blueberry, as well as what genes and metabolites contribute most to blueberry flavor and quality. By using blueberry as a model system we can also understand how abiotic stress imposed by future climate change can alter this perennial cropping system and provide fundamental knowledge about abiotic stress impacts on plant dormancy and reproductive development. This work is currently funded by the Alabama Agriculture Experiment Station and the USDA NIFA.

Potato. Using a systems biology approach, we are working to understand the impact of elevated temperature on tuberization and hormone signaling in potato. By integrating physiology data with next-generation sequencing data and molecular biology techniques we can work to identify the genetic mechanisms underlying fundamental changes in tuber developmental timing under future elevated temperatures and CO₂ concentrations.

Pepper. In a collaborative project we are working to understand the effects of climate variability on host physiology and, in turn, host susceptibility towards pathogens. We are utilizing physiology, transcriptomics, and metagenomics to understand the complex interaction of tropospheric ozone on plant-pathogen interactions using the pepper-*Xanthomonas* pathosystem. This project leverages an open-top field site at Auburn University of which I am currently Director and is funded by the Alabama Agriculture Experiment Station.

Soybean. We have begun working on a new project in soybean focused on understanding the physiological mechanisms underlying decreased nutrient content in C3 crops grown under elevated CO₂ concentrations. This includes a series of controlled growth chamber experiments which will produce physiological and transcriptomic data that will be used as inputs to model the effects of elevated CO₂ on nutrient acquisition and transport in the model legume soybean. This work will then be validated in a field setting using a novel field-based CO₂ fumigation system. This work is currently funded by the USDA NIFA.

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

There are several target audiences that are the focus of effort for the duration of this Hatch Project. They include:

Students: This includes student audiences through both teaching and research mentoring. Undergraduate and graduate students will be served by this project through direct involvement in research projects, data analysis and presentation of their research findings. Undergraduate and graduate students will also be served by this project through formal teaching at Auburn University through the "Climate Change Physiology and Evolution" course annually. Students will also be directly involved in outreach opportunities that will serve the local community.

Breeders: Through collaboration with breeders at Auburn University in the Crop, Soil and Environmental Science, Entomology and Plant Pathology, and the Horticulture department, I will not only include them directly in the research planning, execution and analysis phase of the project, but also help them directly translate the research findings in a way that will facilitate future breeding efforts.

Farmers: Through work with breeders and extension specialists at Auburn University I will work to disseminate findings from my research to fruit and vegetable growers in the Southeast region.

Publications:

1. Sanz-Saez A, Potnis N, **Leisner CP** (*In Revision*) Crosstalk and trade-offs: Plant responses to climate change-associated abiotic and biotic stresses. *Invited Review, Plant Cell & Environment*.
2. Lawas LMF, Kamileen MO, Buell CR, O'Connor SE, **Leisner CP** (*In Revision*) Transcriptome-based identification of genes involved in monotropein biosynthesis and functional characterization of iridoid synthase in blueberry. *Plant Direct*.
3. Rossi G, Woods FM, **Leisner CP** (2022) Quantification of total phenolic, anthocyanin and flavonoid content in a diverse panel of blueberry cultivars. *HortScience*. <https://doi.org/10.21273/HORTSCI16647-22>.
4. Edger PP, Iorizzo M, Bassil NV, Benevenuto J, Ferrao F, Giongo L, Hummer K, **Leisner CP**, Lawas LMF, Li C, Munoz P, et al., (2022) There and back again; historical perspective and future directions for *Vaccinium* breeding and research studies. *Horticulture Research*. <https://doi.org/10.1093/hr/uhac083>. *Impact factor* 6.793.
5. Keshishian E, Cliver B, McLaughlin, W, Hallmark, H, Plackova, L, Novak O, Goertzen L, Cobine P, **Leisner CP**, Rashotte A (2022) Cytokinin response factor 2 is involved in modulating salt stress response. *The Plant Journal*. <https://doi.org/10.1111/tpj.15726>. *Impact factor* 5.775.

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

To address plant responses to climate variability, a multi-faceted research approach that integrates physiology, genomics, modeling, and metabolomics during both vegetative and reproductive development is needed. This integrative approach is used with this Hatch project, providing a framework to generate translational plant science to the broader agricultural community focused on climate-resilient agriculture. This project centers on potato, blueberries, soybean, and pepper, which are crops that are relevant to agriculture in the Southeast U.S., and susceptible to production losses under future climate change conditions. This indicates they can serve as valuable systems to understand climate change impacts on market quality and nutritional composition in plants. Results from this research project will advance our understanding of how future changes in growing conditions imposed by climate change will affect the physiological responses of major fruit and vegetable crops and can guide future breeding efforts to produce more stress-resilient crops.

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

No major changes have occurred with these projects. We encountered an issue at our field site related to the ozone fumigation following an electrical surge due to weather, but we have since mediated this issue.

Currently, this work is supporting the training of a research technician, one postdoctoral researcher and 4 graduate students. All have received collaborative help from other PIs involved in the project across departments (Crop, Soil and Environmental Science, Horticulture, and Entomology and Plant Pathology). Additionally, all members of my research team have had the opportunity to present their scientific research findings at major national and international conferences (e.g., American Society of Plant Biology annual meeting).

We are currently working on several peer-reviewed manuscripts from data generated from this project. We will make these manuscripts open access to better disseminate the research findings to communities of interest. We have also submitted funding to the National Science Foundation Ecology and Evolution of Infectious Diseases program using preliminary data from this Hatch project.

In the next reporting period, we will continue to analyze data related to the temperature impacts on blueberry physiology, gene expression and flavor. We will also analyze the impacts of elevated temperature on blueberry dormancy. We are currently analyzing transcriptome data to determine growth-defense tradeoffs related to ozone and *Xanthomonas* stress in pepper. We are also analyzing transcriptome data related to elevated temperature impacts on tuberization signaling in potato. Finally, we will continue a series of controlled growth chamber experiments to determine the mechanisms associated with decreased nutritional content in soybean seeds when grown in elevated CO₂ conditions.

Biology, physiology, and management of urban arthropod pests in Alabama

Project Director

Arthur Appel

Organization

Auburn University

Accession Number

1017844



Biology, physiology, and management of urban arthropod pests in Alabama

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

Urban insect pests negatively impact humans by infesting their residences, contaminating food and food preparation surfaces, mechanically vectoring disease agents, and having highly allergenic body parts, secretions, and feces. The overall goal of this research is to develop integrated pest management systems for urban insect pests. These systems rely on the biology of the pest as well as its responses to various insecticides and formulations. The studies address specific issues that impact urban insect pest management.

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 studies have investigated widespread resistance and tolerance of German cockroaches to insecticidal bait formulations. These are the most common formulations used for German cockroach control. Our results indicate that although all baits were toxic to multi-resistant strains of German cockroaches, there was significant resistance or tolerance to many formulations that would likely negatively impact field control.

We have also investigated the use of essential oils for urban insect management. These compounds can be very toxic via contact or fumigation but do not leave a relevant residual. Most chemical insecticides no longer provide the anticipated level of control, and significant insecticide resistance has been reported. Therefore, there has been a spike in interest in alternatives to conventional insecticides. Among them, natural products from plants such as essential oils (EOs) and essential oil components (EOCs) have enjoyed the most attention owing to widespread reports of efficacy and toxicity even against insecticide-resistant urban insects. Yet, there is no comprehensive synthesis on the extent and impact of managing urban insects using EOs or EOCs. Such a review is highly relevant since it provides a means to assess the extent of progress made, shortfalls, limitations, and prospects. We hope it can be used to make informed decisions and develop relevant policies reliably. We present the ranges of insecticidal effects of EOs, EOCs, and commercially available EO-based products from laboratory and field studies. Finally, we discuss the gaps in our knowledge and prospects for the sustainable use of EOs.

We investigated the response of gravid female American cockroaches to the presence of parasitoid wasps that lay their eggs and kill cockroach egg cases. Using behavioral and electrophysiological methods, we found that these cockroaches cannot detect the wasps and protect their egg cases. This information supports the use of parasitoid wasps in an integrated pest management system for American cockroaches.

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

There are several target audiences for this work. First, the pest control and chemical industries have benefited by better understanding the limitations of many of the products they use and produce, respectively. Second, homeowners benefit from the availability of better, more effective pest control products for their use. And third, urban entomologists, insect toxicologists, and insect physiologists benefit from the knowledge about insecticide resistance and tolerance.

Proceedings 2022:

Rust, M., **A. Appel**, S-H Lee, and C-Y Lee. 2022. Impact of sprays on baits in controlling German cockroaches, *Blattella germanica*. Pp. 148-151. In Rubén Bueno-Marí, Tomas Montalvo, and Wm. H Robinson (eds.) Proceedings of the 10th International Conference on Urban Pests, Barcelona, Spain.

Refereed publications for 2022:

Smith, C. M., A. M. Chicas-Mosier, **A.G. Appel**, and H. Y. Fadamiro. 2022. Gravid *Periplaneta americana* (Blattodea: Blattidae) fails to detect or respond to the presence of the oothecal parasitoid *Aprostocetus hagenowii* (Hymenoptera: Eulophidae). Environ. Entomol. 51: 1086-1093.

*Oladipupo, S. O., X. P. Hu, and **A.G. Appel**. 2022. Essential oils in urban insect management- a review. J. Econ. Entomol. 115: 1375-1408.

Niitepöld, K., H. A. Parry, N. R. Harris, **A.G. Appel**, J. de Roode, A. N. Kavazis, and W.R. Hood. 2022. Flying on empty: Reduced mitochondrial function and flight capacity in food-deprived monarch butterflies. J. Exp. Biol. 225 (13) <https://doi.org/10.1242/jeb.244431>

Appel, A.G., B. N. Dingha, M. J. Eva, and L. E. N. Jackai. 2022. Toxicity, repellency, and laboratory performance of consumer bait products for German cockroach (Blattodea: Ectobiidae) management. Florida Entomologist. 105: 115-125.

*Oladipupo, S. O., A. E. Wilson, X. P. Hu, and **A.G. Appel**. 2022. Why do insects close their spiracles? A meta-analytic evaluation of the adaptive hypothesis of discontinuous gas exchange in insects. Insects. 13(2), 117; <https://doi.org/10.3390/insects13020117>.

Yihang, Z. Y. Wang, X. Xiong, **A.G. Appel**, C. Zhang, and X. Wang. 2022. Profiles of telomeric repeats in Insecta reveal diverse forms of telomeric motifs in Hymenopterans. Life Science Alliance. 5: 1-15 e202101163.

Gardner, S. T., **A.G. Appel**, and M. T. Mendonça. 2022. Chasing cane toads: assessing locomotive and behavioral changes from northward establishment in Florida. Herpetologica 78: 1-8.

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

These results contribute to better and more effective urban pest control products and methods. The products benefit homeowners directly by providing more effective products for them to purchase. Better products and methods also benefit homeowners who contract with pest management/control companies who now have better products and methods to select from for faster results.

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

Results have been disseminated through refereed journal publications (see above), at scientific meetings such as the Entomological Society of America regional and national meetings, and at extension and outreach events targeting pest control companies.

Cooperative extension articles 2022:

Hu, X. P., and **A.G. Appel**. 2022. Controlling Millipedes. ANR-2943, 4pp.

Smith, C., **A. Appel**, and X. P. Hu. 2022. Cockroach Biocontrol: Parasitoids and Parasites. ANR-2778, 4pp.

Papers presented at professional meetings 2022:

*Oladipupo, S., Y. Laidoudi, J. Beckmann, X.P. Hu, and A. Appel. 2022. Cockroach-associated *Wolbachia* imitate the pattern in their bed bug host-prey. National Conference on Urban Entomology and Invasive Pest Ant Conference, May 15-18, Salt Lake City, Utah.

Peterson, M., X.P. Hu, and A.G. Appel. 2022. The Asian cockroach: biology and management implications from research. National Conference on Urban Entomology and Invasive Pest Ant Conference, May 15-18, Salt Lake City, Utah.

*Ajibefun, F., A. Appel, A. Chicas-Mosier, and H. Fadamiro. 2022. Repellency of six commercial essential oil formulations against Pyrethroid-susceptible and two cross-resistant strains of the German cockroach. Joint Southeastern Branch & APS-CD Meeting, Entomological Society of America, meeting 26-30 March, San Juan, Puerto Rico.

*Smith, C., A. Chicas-Mosier, A. Appel, and H. Fadamiro. 2022. Parasitoid detection and parental care of the American cockroach in response to the presence of the oothecal parasitoid, *Aprostocetus hagenowii*. Joint Southeastern Branch & APS-CD Meeting, Entomological Society of America, meeting 26-30 March, San Juan, Puerto Rico.

*Smith, C., A. Chicas-Mosier, H. Fadamiro, and A. Appel. 2022. Investigation of new cockroach hosts for the oothecal parasitoid *Aprostocetus hagenowii*. Joint Southeastern Branch & APS-CD Meeting, Entomological Society of America, meeting 26-30 March, San Juan, Puerto Rico.

*Griffin, M., A. Chicas-Mosier, C. Smith, and A. Appel. 2022. Oviposition site preference of brown banded cockroaches [*Supella longipalpa* (Fabricius) (Insecta: Blattodea: Ectobiidae)] on common household materials. Joint Southeastern Branch & APS-CD Meeting, Entomological Society of America, meeting 26-30 March, San Juan, Puerto Rico.

*Oladipupo, S., J. Beckmann, X. P. Hu, and A. Appel. 2022. Endosymbiont research as a cross continental tool for urban insect management. Joint Southeastern Branch & APS-CD Meeting, Entomological Society of America, meeting 26-30 March, San Juan, Puerto Rico.

[Using the sediment record to reconstruct the impacts of land-use and allochthonous inputs on the aquatic ecosystems of Alabama](#)

Project Director

Matthew Waters

Organization

Auburn University

Accession Number

1014242



Using the sediment record to reconstruct the impacts of land-use and allochthonous inputs on the aquatic ecosystems of Alabama

Final Result

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

Alterations to water quality in aquatic ecosystems are an integration of the input of materials and the responses of aquatic biota to these materials. This project utilizes sediment cores collected from aquatic environments connected to Alabama to reconstruct land use change through time (materials) and the response of water quality (algae and cyanobacteria) to these materials.

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

We have collected sediment cores from multiple aquatic environments throughout Alabama including all of the reservoirs on the Chattahoochee River adjacent to Alabama, Lake Weiss and Lake Lay on the Coosa River, Wolf Bay and Perdido Bay, and two lakes in the Conecuh National Forest. These sediment records have provided a wealth of information that has forwarded an understanding for each of these groups of systems. For the Chattahoochee Reservoirs, our work has demonstrated that in connected reservoir systems, N and P do not deposit nor transport in the same way. Our original study demonstrated that P deposits and transports based on the placement of reservoirs in the sequence. Data shows that P is deposited in the first reservoir of the systems with decreasing amounts of P being delivered downstream as it moves through each reservoir.

(Webster et al. 2021). However, N is not related in the same way with N dynamics being linked more to residence time of water within each reservoir. As a result, N is related to algal productivity with increased residence time causing more algal growth thus delivering N to the sediment environment. Applying this to management shows that as N and P move differently their relationship (N/P stoichiometry) change with each reservoir suggesting that management should change as well in regards to water quality. The Coosa River reservoirs suggest different phenomenon given that the nutrient source is more nonpoint than the point source of the Chattahoochee River (metro Atlanta). The Coosa River systems show that the channel of the original river system through the reservoir creates a pipeline that moves nutrients. As a result, nutrient deposition is deposited in a non-uniform way creating pockets (hotspots) of nutrient increases through the reservoir system. Our work in the Bays of Alabama have shown two primary conclusions. Sediment cores from Perdido Bay showed that primary producer productivity has been high long before the increases in population in the area with cyanobacteria pigments being high for most of the last 200 years. Work in Wolf Bay, showed that organic matter entering the Bay originates primarily from upstream terrestrial area and has very low signatures of marine influence. Finally, for our work in the Conecuh forest, we have shown that prescribed burning causes 300% increases of P inputs into the system which have caused cyanobacteria increases and hypereutrophic conditions. This input of P is not shared with N since N can form gases and escape during burning. Thus, there is a great reduction in N/P which could be favoring the cyanobacteria.

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

Our target audience for each of these projects are both the managers of these systems and the stakeholders utilizing these systems. For the managers we have actively pursued sharing our data with the managers of these systems. For our work on the Chattahoochee we have partnered with the Army Corps of Engineers, Georgia Power and the Columbus Water Works managers. Our work has allowed conversations with water quality experts utilizing these systems for both recreation and drinking water allowing them to view nutrient dynamics in a new light. As for the Army Corps of Engineers, we have someone from our lab actively participating in bi-weekly zoom meetings where we are allowed to share our results and participate in management decisions. For the Coosa River project, we are actively in conversation with Alabama Power who manages these systems sharing our data and outputs from the research to better understand oxygen dynamics and hotspots that Alabama Power are experiencing with these systems. These conversations have led to interest in us adding Lake Wedowee to our study, which we are seeking funding for. Finally, our work in the Conecuh Forest has opened doors for us to have discussions with forest managers throughout the SE USA on the connections between fire and water quality. These discussions are on going and there has been increasing interest as we share and publish data. As for stakeholders, we have participated in lake meetings where residents have learned of our outcomes and we are attempting to participate in more of these as time moves forward. Most of these meetings have been connected to us by Alabama and Georgia Power and we are continuing to make ourselves available for these meetings in the future.

Products from this Year:

Webster, B.C., M.N. Waters, S.W. Golladay. 2021. Alterations to sediment nutrient deposition and transport along a six reservoir sequence. Science of the Total Environment 785: 147246

MN Waters. 2022. Sediment transport and deposition in reservoirs of the ACF basin. Apalachicola-Chattahoochee-Flint Water Conference, Albany, GA, USA

Benjamin C. Webster, Matthew N. Waters, Stephen Golladay. 2022. Drought Impacts on Reservoir Retention Time in Alabama and the Southeastern United States, Alabama Water Resources Conference. September 7th – 9th 2022, Orange Beach AL.
Oral presentation by Benjamin Webster

Benjamin C. Webster, Matthew N. Waters, Stephen Golladay. 2022. Nutrient and Sediment Transport Between ACF Reservoirs and Retention Time, Georgia Association of Water Professionals. July 17th – 20th 2022, Savannah GA.
Poster presentation by Benjamin Webster

Benjamin C. Webster, Matthew N. Waters, Stephen Golladay. 2022. Comparing Variation in Land Use Impacts on Reservoir Processes on Both the Local and Watershed Scales, Joint Aquatic Sciences Meeting. May 23rd – 27th 2022, Grand Rapids MI.
Oral presentation by Benjamin Webster

Benjamin C. Webster, Gail Cowie. 2022. A Long-Term View of Selected Water-Quality Parameters After Passage of the Clean Water Act: A Watershed Story?, Apalachicola-Chattahoochee-Flint Waters Conference. April 26th – 28th 2022, Albany GA.
Poster presentation by Benjamin Webster

Benjamin C. Webster, Matthew N. Waters, Stephen Golladay. 2022. Clean Water Act's Impacts to Reservoirs and Reevaluating Reservoir Retention Time, Apalachicola-Chattahoochee-Flint Waters Conference. April 26th – 28th 2022, Albany GA.
Poster presentation by Benjamin Webster

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

The broader public has benefited from this research by the managers of these systems are better equipped to manage these systems for optimal use. The general public uses these systems for drinking water and recreation. An increase in water quality benefits these stakeholders by allowing better management and improved water quality. In addition, our desire to meet with the stakeholders have provided some opportunities to share our results and aid in the general public to better understand management decisions and what each person can do to improve water quality in each system.

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 only problem that has impacted this research is the lack of work on Lake Tuscaloosa. This reservoir was included in the original proposal because at the time of submission we were in discussions to receive funding for a sediment study. This funding was cut by the town at the last minute and therefore we have never conducted that objective for the project.

Improving water and energy conservation on Alabama broiler farms

Project Director

Jeremiah Davis

Organization

Auburn University

Accession Number

1012577



Final Report

Final Result

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

The mission of the National Poultry Technology Center is to improve the sustainability of poultry farmers in Alabama and Beyond. The projects that we have been working on address several issues and provide new data on how we manage a broiler farm to improve energy and water conservation.

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 use of our undergraduate researchers over the past two summers have allow us to collect value farm data to create surveys of "where are we on the farm with our housing systems and the use of data." The summary data for the amount of gas leaks on broiler farms was truly eye opening for many growers because the leaks are invisible and typically get covered up by the sheer volume of gas used during cold weather. We have had many producers already check and tell of the large leaks they have found on their farms as a result of our extension efforts using the research data we collected. This directly addresses objective two and has improved the energy conservation on farms that have evaluated their systems.

A second project conducted during the period has quantified the scaling potential for evaporative cooling systems using a farms well water source. The research project has allowed our team to identify scaling quantities and we have identified issues with several common practices we use when cleaning evaporative cooling media. The effort has created a foundation for a series of follow up studies to improve what we know about evaporative media and how we manage these systems.

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

One patent was awarded, one peer-reviewed journal article and ten abstracts were published.

Patent

Wise, D.J., G.D. Chesser, J.W. Lowe, T. Byars, T. Greenway, **J.D. Davis**, and J.L. Purswell. “System for Delivery of Biologics” Filing Date: 12/14/16. U.S. Patent Office. Patent No. 11,330,833. The invention consists of novel systems and methods to mix and apply live biologics and/or any additive having therapeutic or growth-promoting value with animal feed. I was a collaborator on the initial design and led the construction of the initial system with Chesser and Lowe through a competitive internal MAFES Strategic Research Initiative Grant. The system was scaled up through two more iterations.

Peer-Reviewed

1. Linhoss, J.E., **J.D. Davis**, J.C. Campbell, J.L. Purswell, K.G. Griggs, C.M. Edge. 2022. Comparison of commercial broiler house lighting programs using LED and natural light: part 1 – spatial and temporal analysis of illuminance (light intensity). J. Appl. Poult. Res. 31(3): <https://doi.org/10.1016/j.japr.2022.100272>

Abstracts

1. Wall, B.L., J.E. Banegas, O.B. Fiallos, M.S. Rueda, J.J. Flees, **J.D. Davis**, J.L. Purswell, C.W. Starkey, and J.D. Starkey. 2022. Assessment of early-stage thermal variation on embryonic mortality, hatchability, growth performance, and carcass characteristics of broiler chickens. Arkansas Nutrition Conference, Arkansas, USA. Sep 13-15, 2022.
2. Wall, B.L., M.S. Rueda, **J.D. Davis**, J.L. Purswell, C.W. Starkey, and J.D. Starkey. 2022. Evaluation of thermal variation during early-stage incubation on broiler chicken growth performance, carcass characteristics, and the breast meat quality defects, Wooden Breast and White Striping. Poult. Sci. 101 (E-suppl. 1):. *(Volunteered)*
3. Banegas, J.E., B.L. Wall, M.S. Rueda, **J.D. Davis**, J.L. Purswell, C.W. Starkey, and J.D. Starkey. 2022. Assessment of late-stage thermal manipulation on broiler chicken embryonic mortality and hatchability. Poult. Sci. 101 (E-suppl. 1):. *(Volunteered)*
4. Arnold, B., **J.D. Davis**, J.C. Campbell, J.L. Purswell, C.M. Edge, M.S. Rueda, K.G. Griggs, C. Smith. 2022. Survey of gas line leaks in commercial broiler houses. Poult. Sci. 101 (E-suppl. 1): 86. *(Volunteered)*
5. Johnson, E.A., **J.D. Davis**, J.C. Campbell, J.L. Purswell, M.S. Rueda, C.M. Edge, K.G. Griggs, C. Smith. 2022. Assessment of water meter accuracy in commercial broiler houses. Poult. Sci. 101 (E-suppl. 1): 86. *(Volunteered)*
6. Lane, A., **J.D. Davis**, C.M. Edge, J.C. Campbell, J.L. Purswell, K.G. Griggs, M.S. Rueda, C. Smith, and J.L. Linhoss. 2022. Survey of light uniformity in commercial broiler houses. Poult. Sci. 101 (E-suppl. 1): 87. *(Volunteered)*
7. Rezek, J., **J.D. Davis**, J.C. Campbell, J.L. Purswell, C.M. Edge, K.G. Griggs, M.S. Rueda, C. Smith. 2022. Assessment of static pressure accuracy in commercial broiler houses. Poult. Sci. 101 (E-suppl. 1): 86. *(Volunteered)*
8. Rowland, M., G.D. Chesser, J.L. Linhoss, J.L. Purswell, J.C. Campbell, and **J.D. Davis**. 2022. Survey of electrical grounding systems for commercial broiler houses in Mississippi and Alabama. Poult. Sci. 101 (E-suppl. 1): 85. *(Volunteered)*
9. Smith, L., **J.D. Davis**, J.C. Campbell, J.L. Purswell, C.M. Edge, M.S. Rueda, K.G. Griggs, C. Smith, and J.E. Linhoss. 2022. Assessment of temperature sensor accuracy in commercial broiler houses. Poult. Sci. 101 (E-suppl. 1): 86-87. *(Volunteered)*
10. Wall, B.L., M.S. Rueda, **J.D. Davis**, J.L. Purswell, C.W. Starkey, and J.D. Starkey. 2022. Assessment of early-stage thermal variation on broiler chicken embryonic mortality and hatchability. Poult. Sci. 101 (E-suppl. 1): 39. *(Volunteered)*

Envisioning 2050 in the Southeast: AI -Driven Innovations in Ag Conference, I was a Host Committee member and Breakout Session Organizer for the breakout session, "AI applications in livestock management." Mar 2022.

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

Everyone experiencing higher food prices over the past year makes it evident that we must continue to find ways to improve the efficiency of food production. Our research projects develop the on-farm data needed for producers to make sound management decisions. This is coupled with our hands-on extension training efforts that make the information useable for producers to implement on their farms. Making farmers more profitable keeps them and their communities moving forward and hopefully more resilient as we move through an economy with ever-increasing costs of inputs and lack of predictable supply chains.

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 undergraduates from the College of Agriculture participated in the NPTC Research and Extension Experience for Undergraduates (NPTC REEU) during the 2022 summer. Each REEU was responsible for collecting data for individual research projects and developing a related extension article as part of our new NPTC Tools of the Trade Series. Four graduate students participated in farmer-engaged research efforts.

Multiple extension training events were hosted with producers and industry professionals from across the Southeastern U.S. on topics of housing design, management, and maintenance. The estimated annual feed efficiency savings for 2022 is in excess of \$44 million for the integrated poultry companies. This impact is calculated based on a proportion of integrator service technicians that participate in workshops and then successfully implement the training they received at our workshops. My contribution to this impact is approximately \$2 million (5%).

Research efforts and extension training will continue into the next hatch reporting project to continue to improve the sustainability of poultry farmers in Alabama and beyond.

Yield, Insurance, and Adaptation: A Research Program Focusing on Agricultural Production in Alabama and the Southeast

Project Director

Ruiqing Miao

Organization

Auburn University

Accession Number

1012308



The Final report for "Yield, Insurance, and Adaptation: A Research Program Focusing on Agricultural Production in Alabama and the Southeast"

Final Result

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

My hatch project aims to understand a) the impact of climate change on crop yields, b) farmers' adaptation to climate change, and c) the impact of crop insurance on agricultural production (e.g., fertilizer uses).

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

To understand the impact of climate change on crop yields, I have developed a statistical model that regresses corn, soybean, and cotton yields on normal temperature, overheat temperature, and precipitation variables. The analysis is based on county-level data for the rain-fed region in the United States. I find that overheat temperature has statistically significant negative impact on crop yields across all three crops considered. Moreover, I find that this negative impact decreased over the last six decades, which shows crop adaptation to climate change. I further try to identify factors that affect the adaptation.

To understand the impact of crop insurance on fertilizer uses in the United States, I have developed a statistical model that regress the US county-level fertilizer use on crop insurance coverage and other control variables such as local weather. This study finds that crop insurance increases fertilizer uses for corn but has no impact on fertilizer uses for soybeans. For corn, the impact is only temporary (about 5 years). I do not find long-term impact of crop insurance on the fertilizer uses for corn.

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

The target audience include researchers, policymakers, and other stakeholders. The results of the project's activities have been disseminated via research article manuscripts, conference presentations, and university seminars. These outcomes are listed as follows.

Publications:

Miao, Ruiqing, Hongli Feng, David A. Hennessy, Gaurav Arora, and Charles R. Loesch. forthcoming. "Grassland Easement Acquisition: Conversion Hazard Rate, Additionality, Spatial Spillover, and Heuristics." *Applied Economic Perspectives and Policy*. doi: <https://doi.org/10.1002/aep.13318>

Ghosh, Prasenjit*, Ruiqing Miao, and Emir Malikov. forthcoming. "Crop Insurance Premium Subsidy and Irrigation Water Withdrawals in the Western United States." *The Geneva Papers on Risk and Insurance - Issues and Practice*. doi: <https://doi.org/10.1057/s41288-021-00252-4>

You, Yongfa, Hanqin Tian, Shufen Pan, Hao Shi, Zihao Bian, Angelo Gurgel, Yawen Huang, David Kicklighter, Xin-Zhong Liang, Chaoqun Lu, Jerry Melillo, Ruiqing Miao, Naiqing Pan, John Reilly, Wei Ren, Rongting Xu, Jia Yang, Qiang Yu, and Jingting Zhang. 2022. Incorporating dynamic crop growth processes and management practices into a terrestrial biosphere model for simulating crop production in the United States: Toward a unified modeling framework. *Agricultural and Forest Meteorology* (325):109144. doi: <https://doi.org/10.1016/j.agrformet.2022.109144>

Miao, Ruiqing, David A. Hennessy, and Hongli Feng. 2022. "Grassland Easement Evaluation and Acquisition: An Integrated Framework." *Canadian Journal of Agricultural Economics* 70(1):41-61. doi: <https://doi.org/10.1111/cjag.12302>

Khanna, Madhu and Ruiqing Miao. 2022. "Inducing Sustainable Intensification of Agriculture: Insights from Applied Economics." *Australian Journal of Agricultural and Resource Economics* 66(1):1-23. doi: <https://doi.org/10.1111/1467-8489.12461>

Cornish, Brian*, Ruiqing Miao, and Madhu Khanna. 2022. "Impact of changes in Title II of the 2018 Farm Bill on the Acreage and Environmental Benefits of Conservation Reserve Program." *Applied Economic Perspectives and Policy* 44(2):1100-1122. doi: <http://doi.org/10.1002/aep.13185>

Presentations:

"Adaptation to Climate Change of US Agriculture: Technology and Policy." Center on Food Security and the Environment, Stanford University. June 1, 2022, Stanford, CA. (invited)

"Local Adaptation and Maladaptation to Climate Change of US Agriculture." Leo K. Simon Agriculture & Natural Resources Thursday Seminar Series, Department of Agricultural and Resource Economics, University of California, Berkeley. March 17, 2022, Berkeley, CA. (invited)

"Grassland Easement Acquisition: Conversion Hazard Rate, Additionality, and Spatial Spillover." Allied Social Science Associations (ASSA) Annual Meeting, January 7-9, 2022, virtual. (invited)

"The Impact of Crop Insurance on Fertilizer Use in the United States." Biosystems Engineering Graduate Seminar, Auburn University, December 2, 2021, Auburn, AL. (invited)

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

The research project's activities and results quantify the impact of climate on crop yields and the impact of crop insurance on farmers' fertilizer use. The research activities also help understand farmers' adaptation to climate change and seek ways to better adapt, which will mitigate the impact of climate change on crop yields, and therefore, ensure stable prices of food. The general public will benefit from stable food prices.

Moreover, crop insurance is heavily subsidized (about \$6 billion/year) by taxpayers' dollars. On the other hand, we find that subsidized crop insurance increases fertilizer use that decreases water quality. This finding contributes to the debate about whether or not crop insurance should be subsidized in the U.S. It has the potential to impact public policy that may reduce crop insurance subsidy and increase water quality for the general public.

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

Opportunities for training and professional development provided:

One PhD student and one postdoc are trained under the activities under the Hatch project.

This is a final report for the Hatch project because it ended on April 30, 2022.

Critical Issue

Sustainable Energy and Bio-based Products

Regulation of lipid biosynthesis in *Yarrowia lipolytica*

Project Director

Stylianos Fakas

Organization

Alabama A&M University

Accession Number

7000736



Regulation of lipid biosynthesis in *Yarrowia lipolytica*

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

Yeast lipids can be used as raw materials for the production of biofuels (e.g., biodiesel). Yeasts can convert a variety of low-cost byproducts to lipid-based biofuels, but the yield of these bioprocesses is too low to be economically favorable.

The goal of this research is to improve the yields of lipid-based biofuels in order for them to become a sustainable alternative to fossil fuels and to produce lipid biotechnologists who will fill the needs of the biofuel 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.

We are working on the regulation of a catalyst called ATP:citrate lyase which controls the production of cellular lipids. We have identified parts of the catalyst that are potentially important for this regulation and we are studying their structure to get a better understanding of how the catalyst works. We are currently exploring the function of these parts and we are developing methods to modify them.

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

Two PhD students were trained in biochemistry and molecular biology.

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

Understanding the regulation of the catalysts that convert raw materials to lipid-based biofuels will lead to a better understanding of the bioprocess. This knowledge can then be used to improve the yields of lipid-based biofuels.

approach

Project Director

Ernst Cebert

Organization

Alabama A&M University

Accession Number

7000734



Understanding morphological, mechanical and chemical composition properties of Miscanthus stems using a multidisciplinary approach

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

Only a few studies exist on the properties of Miscanthus for its value-added bio-based potential to develop industrial products. This knowledge gap is being addressed to establish the crop's multi-functionality utilization potential. This project will identify the biomechanical and chemical composition properties of Miscanthus stems and explore the genetics of these traits.

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 2022, we tested a few biomechanical properties of Miscanthus stems using a Universal Testing Machine (UTM, ADMET eXpert 7603 5kN). Specifically, we investigated the load, tensile strength, modulus of elasticity, and elongation for different internodes in a time series manner for a Miscanthus x giganteus cultivar (Mxg "Illinois"). Miscanthus stems were collected weekly from October 2022 to February 2023. For each sampling time point, stem samples were further segmented by node, and the first 11 internodes (counting from stem base) were used for biomechanical property measurement. The results show that the biomechanical properties overall decreased over time during the sampling period from October to February. In addition, there exists a decreasing trend in biomechanical properties from the bottom to the top of the stem, with the decreasing trend stronger for the first 5 internodes and for the load, and stress properties.

We are also assessing field lodging as a biomechanical indicator for Miscanthus entries for the 2022 growing season, which is the second year of data for this trait. The two-year data set will shed light on how Miscanthus lodging varies by year and by entry. Miscanthus entries with contrast lodging degrees will be tested for their biomechanical properties.

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

The target audiences include researchers in the field of sustainable bioenergy and broadly plant science and molecular genetics as well as potential Miscanthus growers. Our project activities showed that biomechanical properties in the Miscanthus stem exhibited a stem internodal difference and a temporal decreasing trend when approaching and after maturity, which has implications for harvest timing and strategy implications as well as bioproduct development.

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

Unlocking the genetic potential of Miscanthus to exploit its potential as an industrial crop will allow growers and bio-based product manufacturers to add this new crop to their production/product portfolio. As a perennial species, it offers a sustainable approach for biomass production.

BIOMASS CONVERSION INTO BIOFUELS AND HIGH-VALUE ADDED PRODUCTS

Project Director

Sushil Adhikari

Organization

Auburn University

Accession Number

1021649



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

Our project explored a two-stage bio-oil upgrading for the production of biofuels such as gasoline, diesel and jet fuels. Further, we examined the conversion of waste plastics for energy production using gasification and hydrothermal liquefaction.

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

In our project, we studied two-stage hydrogen treatment to avoid catalyst coking during bio-oil upgrading for the production of transportation fuels. Also, bio-oil was blended with non-edible oil, such as carinata oil to minimize catalyst coking during the upgrading process. Further, the team also explored the yield and the quality of oil produced from household waste plastics.

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

The target audiences of this project are undergraduate and graduate students, post-docs, and the scientific community. This project provided opportunities to learn research skills for undergraduate and graduate students and Post-docs. Undergraduate students learn about experimental design and data collection with accuracy. Graduate students learn analytical skills to characterize biomass, biofuels, and biochemical and also write manuscripts. Post-docs received training on mentoring undergraduate and graduate students, developing research proposals, and writing manuscripts. Graduate students and Post-docs also got opportunities to share their research findings in Biomass and Biofuel course taught by the investigator.

Results were disseminated mainly through published peer-reviewed papers and presentations at national meetings. In some cases, research findings were also shared with industry stakeholders through targeted meetings. The scientific community and industry experts got an opportunity to learn from this project through information published in the peer-reviewed manuscript and presentations given in local, regional and national meetings.

The list of papers published in 2022 are as follows:

1. Poulami Roy, Hossein Jahromi, Tawsif Rahman, Sushil Adhikari, Farshad Feyzbar-Khalkhali-Nejad, Tae-Sik Oh. 2022. Understanding the effects of feedstock blending and catalyst support on hydrotreatment of algae HTL biocrude with non-edible vegetable oil. *Energy Conversion and Management*. Vol. 268, 115998
2. Hossein Jahromi, Tawsif Rahman, Poulami Roy, Sushil Adhikari. 2022. Hydrotreatment of solvent-extracted biocrude from hydrothermal liquefaction of municipal sewage sludge. *Energy Conversion and Management*. Vol. 263, pg. 115719.
3. M Eisa, D Ragauskaitė, S Adhikari, F Bella, J Baltrusaitis. 2022. Role and responsibility of sustainable chemistry and engineering in providing safe and sufficient nitrogen fertilizer supply at turbulent times. *ACS Sustainable Chemistry & Engineering* 10 (28), 8997-9001.
4. Bijoy Biswas, Putrakumar Balla, Bhavya B Krishna, Sushil Adhikari, Thallada Bhaskar. 2022. Physiochemical characteristics of bio-char derived from pyrolysis of rice straw under different temperatures. *Biomass Conversion and Biorefinery*, 2022. <https://doi.org/10.1007/s13399-022-03261-y>
5. O Asafu-Adjaye, Yusuf Celikbag, Jason Street, M Peresin, M Auad, Sushil Adhikari, Brian Via. 2022. Elucidation of the effect of fast pyrolysis and hydrothermal liquefaction on the physico-chemical properties of bio-oil from southern yellow pine biomass as a chemical feedstock. *Bioresources*. Vol. 17 (2), pg. 2176.

6. Osei Asibe Asafu-Adjaye, Jason Street, Archana Bansode, Maria L Auad, Maria Soledad Peresin, Sushil Adhikari, Terry Liles, Brian K Via. 2022. Fast Pyrolysis Bio-Oil-Based Epoxy as an Adhesive in Oriented Strand Board Production. *Polymers*. Vol. 14(6). Pg. 1244.

7. Poulami Roy, Hossein Jahromi, Sushil Adhikari, Y Zou Finrock, Tawsif Rahman, Zabihollah Ahmadi, Masoud Mahjouri-Samani, Farshad Feyzbar-Khalkhali-Nejad, Tae-Sik Oh. 2022. Performance of biochar assisted catalysts during hydroprocessing of non-edible vegetable oil: Effect of transition metal source on catalytic activity. *Energy Conversion and Management*. Vol. 252, pg. 115131.

8. Pixiang Wang, Sarah Tyndall, Tawsif Rahman, Poulami Roy, Hossein Jahromi, Sushil Adhikari, Melissa Boersma. 2022. Sorption and recovery of phenolic compounds from aqueous phase from sewage sludge hydrothermal liquefaction using bio-char. *Chemosphere*. Vol. 287, pg. 131934.

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

It is very early to evaluate how our project has benefited the public. Nonetheless, we work closely with local and regional bioenergy companies to solve problems; sometimes, the knowledge gained from this project is used to solve industry problems. Also, this team has filed a patent on producing biolubricants from carinata oil.

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.

In the next reporting period, we will focus on engineering biochar (a byproduct from pyrolysis and gasification processes) to capture nutrients and other chemicals used in agriculture sector.

Integration of anaerobic digestion with algae cultivation for conversion of agricultural wastes to bioenergy, clean water, and animal feed

Project Director
Brendan Higgins
Organization
Auburn University
Accession Number
1014239



FY 2022 Progress Report

Final Result

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

This project aims to improve the sustainability of agricultural industries through upcycling of wastes into products of value such as animal feed. Specifically, we focus on anaerobic digestion and valorization of the anaerobic digestate through algal production as a means of recovering waste nitrogen as protein. This reduces the negative environmental impacts associated with eutrophication while creating value to agriculture.

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

The specific goals of this project are to:

1. Develop biological pretreatment to overcome recalcitrance of poultry litter to anaerobic digestion

2. Develop physical, chemical, and biological approaches to overcome potential digestate inhibition of algal growth

3. Analyze algal biomass composition to determine suitability for biofuel and animal feed applications including investigation of potential pathogens in the recovered biomass

Goal 1:

No work was undertaken in FY2022 related to goal 1 as this work is complete.

Goal 2:

Anaerobic digestate is rich in nutrients, especially nitrogen and phosphorus, which are major nutrient pollutants if released directly into the environment. Algae use these nutrients to grow, and in the process, remove them from the digestate. Unfortunately, past efforts to grow algae directly on anaerobic digestate have generally not been successful due to the high concentration of inhibitory molecules in digestate. In the 2022 fiscal year, we built on our past success in developing an aerobic pretreatment process to overcome algal growth inhibition on anaerobic digestate. Specifically, we focused on testing two different pretreatment strategies on swine digestate. These included our previously developed aerobic bacterial pretreatment and also biochar pretreatment. Both methods reduced algal growth inhibition on the resulting digestate but the biochar method was somewhat less effective. We also performed untargeted metabolomics analysis on the swine digestate before and after the pretreatments. This revealed a range of molecules that were removed from the digestate during the pretreatments. We focused in the few dozen molecules that were removed and were identified with high confidence by the LC-orbitrap-MS. A similar set of experiments were also carried out using municipal anaerobic digestate. We were able to identify a few “high probability” inhibitors in the two digestates including at least one that was common between the two digestates. We have purchased this molecule: 3-methoxyphenylacetic acid, and will begin conducting dose-response studies soon. The outcome of these efforts is to identify specific types of molecules in digestate that act as algal inhibitors.

We also have drafted an article related to the outdoor study of our algal treatment system for anaerobic digestion. This study was carried out in three 2 L photobioreactors and began in October of 2020 and ended in October of 2021. This article will soon be submitted.

In fiscal year 2022, we also made significant progress in advancing our understanding of algal promotion of nitrifying bacteria. This is important because nitrification converts ammonium to a less toxic form of nitrogen (nitrate). Nitrate is also the preferred form for plant production. We wrote up and submitted an article to ACS Environmental Science & Technology, Engineering on our study of how algae, nitrifying bacteria, and poultry processing aids interact. This study showed that algae could promote nitrification, even when common antimicrobial agents are present. In 2022, we also constructed and began testing a pilot scale system for poultry wastewater nitrification in conjunction with hydroponic lettuce production. We began our first treatment and lettuce growth trial right at the end of FY2022. Finally, we repeated a batch study investigating the ways in which two different green algae species can promote nitrification in poultry processing wastewater. We found that photosynthetic oxygenation by algae was not a primary promoter of nitrification despite the prevalence of this hypothesis in the literature. Rather, secretions of beneficial molecules by algae or uptake of inhibitors by algae was a primary mechanism of symbiosis. Future work is needed to understand the specifics.

Goal 3:

We began development of a large-scale treatment train for anaerobic digestion of fish waste solids. The aim of this system is to grow large enough quantities of algae to feed crayfish as part of a feeding trial. Specifically, we aim to test a diet of 100% digestate-grown algae vs. a diet of 100% shrimp feed (standard practice) vs. a blend. To this, we first need to complete the treatment train. At this point, we began assembling three 65 gallon anaerobic digesters for treatment of fish waste solids in our aquaponics system. We also did some compositional analysis of the algal consortium that was successfully used to treat digestate in the year-long outdoor study mentioned above. The composition has proven fairly similar to our previous analysis of *Chlorella* monocultures in terms of crude protein (~40%). This consortium will be used as part of the above treatment train once assembly is complete.

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

Target Audiences:

1. Academic community of Biosystems Engineers
2. Poultry Growers
3. Dairy farmers
4. Poultry processors
5. Wastewater Utilities

Our development of novel bioprocesses for waste upcycling are of interest to these industries because they a) spend considerable resources disposing of waste and b) stand to benefit in the long-term from the sale of new products that these processes enable. Below is a list of publications and presentations associated with this project:

Peer-reviewed articles:

1. Kalvakaalva, R., S.A. Prior, M. Smith, G.B. Runion, E. Aiyipio, C. Blanchard, N. Wall, D. Wells, T.R. Hanson, **B.T. Higgins**. 2022. Direct greenhouse gas emissions from a pilot-scale aquaponics system. Journal of the ASABE. 65(6): 1211-1223. doi: 10.13031/ja.15215
2. Smith, J., Q. Wang, **B.T. Higgins**. Determining the ability of polyphosphate accumulating organisms to use organic compounds in algal photosynthate. Auburn University Journal of Undergraduate Scholarship: 2022 issue.

Conference abstracts:

1. **Higgins, B.T.**, S. Rezaei. 2022. Investigation of decoupled algal-biofloc aquaponics technology for deployment in food deserts. AU Aquaponics Symposium. Auburn, AL. Sep 29.
2. **Higgins, B.T.**, S. Adhikari. 2022. Insights from year 1 of the REU Site: Research experience through collaborative teams in bioprocessing for conversion of waste into products of value. ASEE NSF EEC Grantees Conference. Arlington, VA. Sep 22-23.
3. **Higgins, B.T.**, M. Thomas, S. Sprague. 2022. Using molecular tools to discover organisms responsible for taste and odor episodes in a drinking water reservoir. Alabama Water Resources Conference. Orange Beach, AL. Sep 7-9.
4. Arthur, W., M. Reina, L. Orellana, A. Urrutia, A.P. Jackson, S. Kitchens, K.S. Macklin, S.B. Price, **B.T. Higgins**, D.V. Bourassa. 2022. Microbiological survey of wastewater and solids from poultry processing plants after DAF treatment. Poultry Science Association Annual Meeting. San Antonio, TX. Jul 11-14.
5. Wang, Q., **B.T. Higgins**. 2022. A long-term outdoor algal culturing study using high-strength anaerobic digestate (oral). International Meeting of American Society of Agricultural and Biological Engineers. Houston, TX. Jul 17-20.

6. Wang, Q., Alireza Fallahi, Alan E. Wilson, **B.T. Higgins**. 2022. Engineered algal systems for the treatment of anaerobic digestate: a meta-analysis (poster). International Meeting of American Society of Agricultural and Biological Engineers. Houston, TX. Jul 17-20.
7. Wang, Q., **B.T. Higgins**. 2022. A bacterial pretreatment for enhanced algal biomass production and nutrient removal from undiluted anaerobic digestate AU Huntsville Symposium. March 29.
8. **Higgins, B.T.**, J. Box, E. Childree, Q. Wang. 2022. Leveraging algal-bacterial synergy for treatment and re-use of wastewater for irrigation. AU Huntsville Symposium. March 29.
9. Blanchard, K., Y. Bao, **B.T. Higgins**, D. Wells. 2022. Using Reinforcement Learning to Balance Aquaponic Crop Production and Environmental Impact. AI in AG. Auburn University. March 9-11.
10. Smith, J.3, Q. Wang2, **B.T. Higgins**. 2022. Student Research Symposium. Auburn University. March 28th.
11. Dickson, B.R., G. Au, D. Gomez-Maldonado, **B.T. Higgins**, M.S. Peresin. 2022 Nanocellulose-based antimicrobial systems for mitigating E.coli outbreaks in water bodies. Student Research Symposium. Auburn University. March 28th.

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

The general public benefits from the improvement in agricultural sustainability that this project enables. This includes less water pollution, lower greenhouse gas emissions, and less wasted natural resources. It also helps ensure long-term sustainable food production in spite of growing global populations. Elimination of waste and increased resource use efficiency are imperative. Our processes that upcycling waste nutrients back into animal feed and food support both of these outcomes.

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.

Communication of results to communities of interest:

The majority of communication modes (peer reviewed articles and presentations) have targeted academic audiences in Biosystems Engineering and Environmental Engineering. This is appropriate given the basic discoveries that were required to advance these technologies. However, we have also worked with three regional poultry processing plants who have kindly provided us with materials. We have also communicated results with wastewater utilities who have also contributed material support for this project.

Training and Professional Development

This project has resulted in the training of 4 PhD students, 3 master's student, and 4 undergraduate student researchers over the 2022 fiscal year. One PhD student and one master's student graduated with degrees in Biosystems Engineering in 2022. Many of these students have had opportunities to present their work at conferences and symposia. Two of my students were first authors on papers published in 2022.

Nanocellulose-based materials for novel applications

Project Director

Maria Peresin

Organization



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

A major goal of this project is to utilize natural resources (wood pulp, sawdust, soybean hulls) to produce nanocellulose with varying chemical compositions to develop added-value products to be used in film composites, membranes and filters for water purification. Specific objectives of the project include: 1) understanding the role of chemical composition of different sources of biomass in properties such as wettability, adhesion parameters and interphase interactions of CNF and its nanocomposites in terms of performance of the final product and 2) to develop efficient strategies to improve interfacial adhesion between the nanofibrils and polymeric matrix to maximize the strength of final products (e.g. composites).

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

We have developed strategies that allowed us for the valorization of a variety of biomass sources such as cotton linters, peanut hulls, tara gum residues, as well as downed timber from catastrophic events. Such valorization is focused on the isolation of nanocellulose fractions from said biomass sources and further valorization in composite materials for the manufacture of composite materials.

We made significant strides on developing a method to assess degradation profiles of timber that is left behind on the field after a storm. Said method consists on a non-destructive evaluation sound-wave propagation, and density measurements of downed timber. This data can then be correlated with chemical characterization of the wood in order to establish the utilization window of the timber for cellulose and other woody polymers isolation and use.

Nanocellulose, hemicelluloses and lignin fractions were used to create composite films at different ratios in order to improve water swelling. Tara gum, nanocellulose and lignin films were successfully produced and they show promising properties for packaging, transparent materials.

Additionally, nanocellulose fractions from different sources were used as additive to commercial adhesive systems for wood composites with construction applications as a target. Addition of lignin containing nanocellulose to a variety of resins such as phenyl formaldehyde and epoxy resins, showed an improved performance of the composites, indicating that residual lignin improves the interfacial adhesion of wood composites. Applications of interest in this topic include the development of environmentally friendly wood composites for additive manufacturing in construction.

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

We have disseminated the findings of this project in a variety of scientific outlets such as presentations in meetings of the American Chemical Society, Forest Products Society, TAPPI Nanotechnology Division, as well as internal meetings at Auburn University.

We have published some of this data in peer-reviewed articles in the following journals: Forest Products Society, Surfaces and Interfaces, Water, Oil & Soil Pollution, Forests, BioResources, Polymers and Cellulose.

Peer-reviewed publications:

- Gomez-Maldonado, D., Filpponen, I., Erramuspe, I. B. V., Johansson, L. S., Mori, M. F., Babu, R. J., ... & Peresin, M. S. (2022). Development of a β -cyclodextrin-chitosan polymer as active coating for cellulosic surfaces and capturing of microcystin-LR. *Surfaces and Interfaces*, 33, 102192.
- Gomez-Maldonado, D., Ponce, S., & Peresin, M. S. (2022). The Applicability of Cellulose—Tara Gum Composite Hydrogels as Dye Capture Adsorbents. *Water, Air, & Soil Pollution*, 233(8), 1-12.

- Musah, M., Diaz, J. H., Alawode, A. O., Gallagher, T., Peresin, M. S., Mitchell, D., ... & Via, B. (2022). Field Assessment of Downed Timber Strength Deterioration Rate and Wood Quality Using Acoustic Technologies. *Forests*, 13(5), 752.
- Vallejos, M. E., Olmos, G. V., Taleb, M. C., Felissia, F. E., ?Ehman, N. V., Peresin, M. S., ... & Maximino, M. G. (2022). Dissolving pulp from eucalyptus sawdust for regenerated cellulose products. *Cellulose*, 29(8), 4645-4659.
- Asafu-Adjaye, O., Celikbag, Y., Street, J., Peresin, M., Auad, M., Adhikari, S., & Via, B. (2022). Elucidation of the effect of fast pyrolysis and hydrothermal liquefaction on the physico-chemical properties of bio-oil from southern yellow pine biomass as a chemical feedstock. *BioResources*, 17(2), 2176.
- Asafu-Adjaye, O. A., Street, J., Bansode, A., Auad, M. L., Peresin, M. S., Adhikari, S., ... & Via, B. K. (2022). Fast Pyrolysis Bio-Oil-Based Epoxy as an Adhesive in Oriented Strand Board Production. *Polymers*, 14(6), 1244.
- *Hernandez, J. A., Soni, B., Iglesias, M. C., Vega Erramuspe, I. B., Frazier, C. E., & Peresin, M. S. (2022). Soybean hull pectin and nanocellulose: tack properties in aqueous pMDI dispersions. *Journal of Materials Science*, 57(8), 5022-5035.

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

We have engaged with a number industrial partners who are interested in commercializing some of the technology developed in these projects. We are actively working with our office of technology transfer in identifying ways of continuing working with these groups on transferring technology.

We have engaged with different community groups at different age levels to disseminate our work, from elementary to high school level students, as well as with farmers associations (**Georgia** Division of the **Southeastern Society** of American Foresters) and public in general, intentionally targeting underrepresented minority groups.

The Sustainable Bio-Based Materials laboratory in collaboration with the Auburn chapter of MANRRS (Minorities in Agriculture, Natural Resources and Related Sciences) hosted the first edition of “Rallying for sustainable communities” in April 2023, an outdoors demonstration rally for children 1-3 grades where they learned about the importance of sustainable development of communities through recycling and the use of bio-based materials. Additional groups we presented to and interacted with include Junior MANRRS, AU Young Professionals in Training, Girls Scouts of Alabama.

Type

Projects / Programs without a Critical Issue

Not Provided

Projects/ Programs

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