Alabama (Alabama A&M University, Auburn University, Tuskegee University Combined) Annual Report - FY2021

Report Status: Approved as of 07/08/2022

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 (LGU) has distinct programs 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 programs 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 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 programs 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 FY2021-2025 Plan of Work were developed within the context of research and community engagement of 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

Community Development initiatives have assisted the Alabama workforce return to work as the pandemic subsided. The State's current unemployment rate stands at 2.9%. The contributions to workforce preparation have connected local, state, and federal agencies, schools, community groups, labor, employers, and others, to further the workforce development of youth and adults. Programming efforts are expanding to improve workforce awareness, knowledge, and skills throughout Alabama, with particular emphasis on entrepreneurship, broadband adoption, science, technology, engineering, and mathematics (STEM), career education and planning, and technology applications that support workforce development.

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

COVID-19 has taken a significant toll on all aspects of family life. Strengthening families programs, to include 4-H and youth development, have focused on addressing these challenges. Renewed emphasis has been placed on (a) improving family relationships, (b) financial resource management, (c) identity theft and fraud prevention, (d) mental health, (e) isolation, and (f) parent education. During the two-year pandemic, many Alabama youth have fallen behind in acedemic development. 4-H and youth development programs have been adjusted to fill the gap by emphasizing 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.

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 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 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.

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

Preventable diseases such as obesity, diabetes, high blood pressure, and vascular issues are mostly caused by the lack of nutrients, the lack of exercise, poor life style choices, and stress of the involved individuals remains an ongoing effort. The issue of growing health concerns for Alabama citizens, especially in rural areas, has resulted in combined efforts to educate and motivate citizens throughout the state to make better health decisions. Health disparities/inequities are influenced by the level of knowledge, access to healthcare, and the ability to self-manage. We expect that health science initiatives will become an ever important component of the land-grant portfolio of projects and programs in the near term.

Critical Issue: Natural Resource and Environmental Sustainability

Agricultural and natural system sustainability is critical in the face of climate change. Ongoing efforts focus on faclitating 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; remote sensing and precision agriculture.

Critical Issue: Sustainable Energy

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, and technology development for bioenergy conversion.

Merit and Scientific Peer Review Processes

Updates

None.

Stakeholder Input

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

None.

Methods to identify individuals and groups and brief explanation

None.

Methods for collecting stakeholder input and brief explanation

None.

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

None.

Highlighted Results by Project or Program

Critical Issue

Community Development

Carver Integrative Sustainability Center's Future Farmer and Agricultural Specialists (CISC 2FAS)

Project Director

Raymon Shange

Organization

Tuskegee University

Accession Number

7002769

Carver Integrative Sustainability Center's Future Farmer and Agricultural Specialists (CISC 2FAS)

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

Agriculture in America plays an essential role in the nation's economy and ability meet basic necessities of food, clothing, and nutritional security. There is a growing need for agricultural products processes, and professionals to meet the demands of a growing human population in the face of a changing climate/environment. The value of experiential learning in agricultural education has long been recognized as an important part of the process as workforce development in such areas is an imperative for our nation to remain economically viable.

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 Future Farmers and Agricultural Specialists program at Tuskegee University employs three apprenticeship/training programs (Summer Agents, CISC Summer Experience, TUCE Intern Program) of which the first two are 8 week site specific programs, and the last program is a year long apprenticeship. Students spent time working alongside farmers, extension agents professionals, agribusiness entrepreneurs, and community-based organizations while learning their craft. There were also mandatory certification courses in Geographic Information Systems, Food Safety, Solar Energy Installations, and Sustainable Food Systems delivered with weekly workshops/seminars.

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

Of the 38 participants, 100% of the interns reported a gain in knowledge of what the components of a food system are and how these components can be influenced, while 95% increased their knowledge in the use and application of Geographic Information Systems. 82% of the participants indicated an increased likelihood to pursue a profession in agriculture and related sciences.

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

The broader public benefits from having a rising workforce that is trained in agricultural, environmental, and energy systems that will allow them to enter the workforce at multiple levels. There is also less potential for the loss of institutional knowledge from older generations of farmers and workers that participate as mentors in the program, and we are hopeful to increase the likelihood that these young people will live and work in the communities that we are helping to train them in.

Small Business Development Program

Project Director

Raymon Shange

Organization

Tuskegee University

Accession Number

7002770

Small Business Development Program

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

Small business in the Black Belt Region of Alabama have had some historic challenges in being sustainable over long periods of time while still serving their local communities. These businesses continually face issues such as: 1) Access to capital, 2) Lack of social capital/networks, 3) Balancing quality and growth. Even though there seems to be a large consumer support base in the African American communities in the Black Belt and surrounding counties, there still seems to be challenges for sustainability. The onset of the pandemic in 2020 and the accompanying recession has seemed to exacerbate the challenges faced.

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.

Faced with the other accompanying challenges of the pandemic, TUCE held a virtual summits to address the needs of Black Belt small businesses. The second of the two summits was the Annual Booker T. Washington Economic Development Summit. The summit was held across two days, and focused on 1) Sustainable Green Businesses, 2) Electronic Markets, and 3) Capital Access. Another approach to extension in this manner was one-on-one technical assistance and workshops. The focus on was small businesses development through 1) Credit Repair, 2) Record Keeping, and 3) Loan Access. There were also targeted outreach and technical assistance provided to small business owners.

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

The summit and technical outreach together produced 420 participants mainly located in the AL Black Belt (75%), but from 4 other states as well. The technical outreach workshops were attended largely by professionals (77%) while the participants of the BTW Summit largely described themselves as small business owners or serving these entities (78%). Ninety percent (90%) of the participants stated that they gained sills that they anticipate using over the next year in their business and/or workplace.

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

The broader public benefitted from this activity insofar as that we can increase economic activity and small business development in the Black Belt of Alabama. This is not just an asset to the region, but to the entire state.

Critical Issue

Family, Home, and 4-H and Youth Development

4-H Volunteerism

Project Director

Mary Gregg
Organization
Auburn University
Accession Number
7002155

4-H Volunteerism

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

The recruitment, screening, enrollment, training, and management of 4-H volunteers is critical to support Alabama 4-H's capacity to make 4-H accessible to all youth and both youth and volunteers safe.

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.

Alabama 4-H staff manage and support a comprehensive 4-H volunteer recruitment, screening, training, enrollment (4HOnline), and management system with institutional support of Auburn University Office of Risk Management and Safety to further the youth educational efforts of ACES and 4-H in all 67 counties. 1,322 direct volunteers and an additional 1,783 resource volunteers (3,105 total) reached more than 71,241 4-H members with 4-H programs during the 2020-2021 club year.

3,105 4-H volunteers reached more than 71,000 4-H members in 2020-2021 Club Year (August 1, 2020 – July 31, 2021). This included a 4-H club year riddled with COVID19 pandemic protocols, school closings, and school visitor limitations where all 4-H face to face activities were suspended. • 80,934 hours of service time were reported valued at $2.3 million in economic contribution; the equivalent of 40 full

time 4-H employees.

3,105 4-H Volunteers in the Alabama 4-H Youth program model and mentor service to theircommunities resulting in 71,241 4-H 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). “Not everything that counts can be counted. And not everything that can becounted, counts.” – Albert Einstein. This is particularly true of the long-term impact a caring adult has on the life of a young person. We can say that Alabama 4-H volunteers had an economic impact of $2.3 million in 2020-2021 but even more importantly, 4-H volunteerism is about giving, contributing, and helping other individuals and the community at large. It is working with others to make a meaningful contribution to a better community. 4-H alumni agree that 4-H made a difference in their lives because they: - Were involved in planning club activities (Belonging) - Were free to develop and use their skills (Mastery) - Had an opportunity to lead others (Independence) - Had an opportunity to contribute (Generosity) How does volunteering impact the 4-H volunteers? - 4-H provides adult volunteers with the opportunity to be involved with youth and youth learning. - 4-H gives adults opportunities for personal growth.

Staff and 4-H volunteers managed 3,387 4-H Clubs to 40,452 4-H Club Members

-780 4-H Community Clubs

-2,496 4-H In-School Clubs

-110 4-H Afterschool Clubs

-1 4-H Military Club

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

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. 71,241 4-H members are safer because of stringent screening, training and orientation procedures for 4-H volunteers in the

areas of:

-sexual misconduct

- identifying, reporting and preventing abuse

-diversity and inclusion

-ages and stages of positive youth development

-risk management

-first aid and safety

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

Alexis Tocqueville in his publication, *Democracy in America,* writes,

In the United States, as soon as several inhabitants have taken an opinion or an idea they wish to promote in society, they seek each other out and unite together once they have made contact. From that moment, they are no longer isolated but have become a power seen from afar whose activities serve as an example and whose words are heeded.

4-H volunteerism by both adults and youth, provides services to those in need and more often then not serves a broader purpose - to prepare young people to be better citizens, workers, and family members. This is accomplished by uniting and bonding youth and adults and communties in a common cause enabling us to see the power of human ineteraction for the good. Human inteaction for the betterment of communities and individuals are foundational for developing empathy, common understanding and compassion which are essentials elements for a civil world.

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.

Despite the challenges of COVID, Alabama 4-H and its incredible cadre of volunteers found a way to get the work done. Technology innovations and uique program delivery methos will be added to our collective tool box for expanding reach and inclusion. This inclues but is not limitied to project bags, curbside animal pick-up (chicks and rabbits), and technology (zoom) accessibility included with face-to-face proramming for those that have access but travel remains a barrier.

4-H Youth Council - Youth Leading other Youth

Project Director
Mary Gregg
Organization
Auburn University
Accession Number
7002156

"4-H Youth Council - Youth Leading Other Youth"

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

Raising the next generation of leaders, regardless of the leadership role, is critical for the social, emotional, and economic success of our world. Alabama 4-H provides experiences and opportunities for young people to build individual and collective capacity to lead.

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 County 4-H Youth Council is a committee appointed by the County 4-H Team. The Youth Council consists of active 4-H members between the ages of 10-18 years old who have at least one year of 4-H experience. Youth Council members also reflect the demographics of the county they are serving. The County 4-H Youth Council provides members with an opportunity to develop enhanced citizenship and leadership skills, serve as local 4-H ambassadors, function as youth/client advisors, and leverage 4-H programming with their peers.

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

Two-hundred and ten youth making up 67 county youth councils, were provided opportunities and experiences to learn, appreciate, and apply leadership/life skills that demonstrate

• Appreciation for the difference in others

• Recognin of problems and development action plans to solve them

• Achievement of teamwork and group building skills

• Assuming responsibility for actions and following through on goals

• Improvement of written, verbal, and interpersonal communication skills

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

Leadership and citizenship skills are important in any Alabama 4-H program. Youth from across the state had an opportunity to provide their feedback on their leadership and citizenship abilities after participating in the Youth Council program. Positive changes in knowledge, action, and and condition are listed below.

Before: Starting Youth Council: I worked successfully with a team and independently 61 of the 210-youth agreed with that statement.

After being involved in Youth Council 142 youth were able to work successfully with a team and independently. Which indicates an 81**%** increase in teamwork and independent work ethic.

Before: Starting Youth Council: I appreciate differences in others: 82 of the 210-youth agreed with the statement.

After being involved in Youth Council 143 youth were able to appreciate the differences in others. This indicates a 61 **%** increase in appreciating the differences of others.

Before: Starting Youth Council: I worked hard to master goals: 59 of the 210 youth agreed with the statement.

After being involved in Youth Council 133 youth were able to do things that make a difference in their community. Which indicates a 74 **%** increase in mastering goals they set for themselves.

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 2021 club year, the 4-H Youth Council members truly missed the sense of belonging in 4-H. Due to the COVID 19, active Youth Council members were unable to meet face to face for months. Being able to conduct Youth Council meetings via Zoom allowed the young people to work together as a team and provide positive impact and support from each other. Through leadership and communication, the youth improved their skills while developing a sense of pride in their communities.

Due to COVID 19, the hands-on community service component lacked due to COVID restrictions. The Youth Council members and agents across the state improvised and gave back to the community in a variety of ways. Some examples include prerecorded messages to residents in assisted living facilities as well as agents delivering hand-made 4-H cards to community

agents and hospitals as well as 4-H project bags to youth in unique locations: food banks, parks and recs when and if possible, housing authorities, libraries, and schools.

Alabama 4-H Animal Programs
Project Director
Mary Gregg
Organization
Auburn University
Accession Number
7002157

Alabama 4-H Animal Prorams

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

The issue is 4-H members want opportunities to engage in and learn about animal programs. This program is important because it contributes to skill development in animal care, responsibility, record keeping, communication, animal training, and teamwork.

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 outputs of the 4-H animal program include 4-H Chick Chain, Pig Squeal, Livestock Weekend, Livestock Judging Contest, State 4-H Horse Show, Horse Active Education Day, Poultry Week, Golden Egg Contest, Rabbit Project, State Fur & Feathers Show, Dairy Bowl, Dairy Judging Contest, Dairy Project, and Dairy Poster Contest. These are state level competitions that are coordinated by extension personnel in whole or with stakeholders. In the 2020-2021 club year, due to COVID concerns, we did not hold all of these events. We held the Dairy competitions in conjunction with the Alabama National Fair, 4-H Golden Egg Contest, 4-H Dairy Poster Contest, 4-H Chick Chain, 4-H Pig Squeal, 4-H Egg Cookery CyberClub, State 4-H Horse Show, 4-H Horse Active Education Days, 4-H Livestock Judging Contest, 4-H Livestock weekend, 4-H Poultry Week. Some of these events were postponed from their original dates due to COVID. 6,272 chickens raised; 3 national winners, 448 pigs raised, 297 rabbit project participants, 151 horse project participants, 110 beef project participants, 88 dairy poster participants.

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

The target audience are 4-H members and 4-H Volunteers. By providing the opportunities for 4-H youth to engage in programs within their counties, they learned how to raise chickens and pigs in the Chick Chain and Pig Squeal programs. The same is true of the 4-H Rabbit Project. By providing contests and events around the state, such as the State 4-H Horse Show, Livestock Weekend, or Poultry Week activities, we allowed members to test their knowledge and skills that they gained over the course of their year in 4-H.4-H members were able to engage in high quality programs and events that tested their knowledge and skills. Members could see where they excelled and where they needed to work on their knowledge and skills through the scoring and performance at the events and programs. Volunteers shared their knowledge and life experience to build the next generation of community leaders, parents, citizens, and workers.

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

Youth participating in animal projects learn about the proper care and responsibility of taking care of a living creature. These skills transfer to adult and family life. In addition, youth build skills in entrepreneurship, leadership, communication, problem solving and critical thinking in addition to sportsmanship. These life skills transfer to not only adult and family life but work life and community life. Animal projects also expose youth to a wealth of career occupations that are needed for the future economic and social success of our communities world.

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.

Unlike some program areas, COVID increased interest and participation in animal projects. Animal programs allowed youth to work independently at home with their animals and zoom and other technologies allowed for learning, home visits, fellowship. One of the most innovative strategies for animal disbursement was counties creating safe spaces following COVID guidelines where youth and families could have curbside animal pick-up. Technologies used will continue to be a part of the 4-H program delivery toolbox.

Rural Delivery of Alabama 4-H: ACES Auburn University

Project Director
Paul Brown
Organization
Auburn University
Accession Number
7000050

"Rural Delivery of Alabama 4-H: ACES Auburn University"

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

Rural communities are shrinking in Alabama. In some counties, the viability of public-school systems is being questioned. This has the real potential to create educational deserts and to severely limit development opportunities youth need to make critical life decisions.

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.

41 4-H FREAs Functioned in 59 “Rural Counties” last club year

MEMBERSHIP

- **4-H Members**: 21,694
- **4-H Participants:** 19,066
- **Total**: 40,760

EDUCATION

- **4-H Educational Activities:** 7,969
- **4-H Project Bags Distributed:** 36,127
- **4-H Educational Videos Produced:** 181
- **4-H Nearpod Lessons Created:** 172

- **4-H Teams Lessons Shared:** 119

- Approximate;y 128,036 hours of engaement

- **Campers:** 841

FUNDING

4-H Revenue Generation 2020-2021 (Took out 8 designated urban counties)

Cash Donations: $594,796.30

- **In-Kind Donations:** $1,295,329.94

- **4-H Program Fees Collected**: $215,744.05

- **4-H Grants Received:** $215,964.94

- **34** 4-H Foundation Scholarship Recipients

TOTAL: $2,321,835.23

Volunteers

- 988 Direct Volunteers (74.7% of States Direct Volunteers)

- 1332 Resource Volunteers

-

- 60,457 Hours

- $1.7 Million Economic Impact

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

In shrinking rural counties, 4-H is providing youth with opportunities and experiences to participate in decision making, youth governance, and youth adult partnerships through program and under the care and passion of professional staff and volunteers. In communities that may appear hopeless and bleak, 4-H provides experiences and support for youth to strengthen their sense of identity, strengthen their belief in a positive future as well as developing their social, emotional, cognitive, and behavioral competence.

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

The commitment of the Alabama Cooperative Extension System, at Auburn University, to fund positions in some rural communities provides much needed community economic stimulus. Maintaining a 4-H staff position and a county office staffed by a county extension coordinator and administrative professional is a critical component of community and economic life. Four-H provides a no-cost program that makes programming accessible despite ongoing barriers - the lack of transportation, shrinking schools, struggle for teachers, and resources to help youth learn, develop life skills, and develop the attitudes and drive to become self-directing productive family members, workers, and citizens.

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.

Rural communities were hit in unique ways buy COVID. Based on reporting, more schools remained closed for longer periods of time and getting educators to return to face-to-face instruction has been a challenge. Staff had less access to youth and engaging them through technology could be difficult given aces to internet ser45vices. 4-H project bags became important resources for distribution in non-conventional ways for remaining visible and assisting community youth: court system, courthouse, food banks - any venue open where families or youth would come. With the rising cost of gas and consumables, as a program and a system, we will face new and similar barriers that we must find innovative ways to overcome. As a program, as we are committed to using our travel dollar o support face-to-face interaction with young people and to take the program and interaction to where they are.

For Clarity of data a brief discussion of multiple meanings of rural and as defined here.

- **According to the 2020 Census criteria:** Minimum Qualifying Threshold: An area will qualify as urban if it contains at least 2,000 housing units or has a population of at least 50,000.

- **According to the USDA website:** urban areas with populations ranging from 2,500 to 49,999 that are not part of larger labor market areas (metropolitan areas).

- **Urban Counties in AL (as defined by ACES):** 9

Rural Counties in AL(as defined by ACES): 58

AU 4-H Agents in Urban Counties (as defined by ACES): 9

AU 4-H Agents in Rural Counties (as defined by ACES): 53

Money Smart for Adults

Project Director
Paul Brown
Organization
Auburn University
Accession Number
7002293

Money Smart for Adults

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

Money Smart for Adults is a statewide career development project implemented by the Financial Resource Management and Workforce Development Team. The program provided adults with the practical knowledge and resources to build the skills to manage their personal finances with confidence. The target audience are individuals who are establishing their financial lives and credit histories, and others who would like to improve their financial situation. The program targeted adults in Alabama, but also reached 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.

The activity-based program reached 4,069 participants through 367 activities across 54 counties. The curriculum was implemented virtually and in-person by eight (8) financial resource management and workforce development (FRMWD) regional extension agents. Lessons were offered both in a series and as individual workshops. The program was conducted at transitional housing communities, empowerment and economic improvement non-profits, housing authorities, senior centers, career centers, and community centers. Attendees were encouraged to complete an Extension prep/post evaluation.

Across the 5-lesson Money Smart for Adults curriculum, participants 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.

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

There were significant increases in knowledge about money management skills five topic areas: banking, credit, identity theft, saving, and spending planning.

Statistically significant improvements to banking intentions as a result of activity completion include opening a savings or checking account, shop and compare financial products, services, and providers, and have paychecks directly deposited. The most significant banking intention improvements are participants plan to actively avoid payment of non-sufficient fund (NFS) charges, and make money deposits into a savings account.

12.6**%** of participants set a credit intention to use no more than 30**%** of available credit, 8**%** intended to actively decrease debt levels, and 15.6**%** intended to use options to avoid alternatives financial services as a result of credit activity completion.

Statistically significant improvements to identity theft & scam related intentions as a result of activity completion include 14**%** who will actively monitor credit reports, bank and credit accounts for signs of identity theft, and limit the amount of personal information provided on social media sites.

As a result of attending a savings workshop, 11**%** of participants plan to implement monthly expense tracking, Save my change each week toward savings, 10**%** plan to place tax refunds into a savings account, and actively reduce expenses each month.

Statistically significant improvements to spending planning intentions as a result of activity completion include 17.1**%** intentions to begin using the ACES Money Management calendar, 20.6**%** intentions to begin tracking spending, and 12.8**%** to Use the ACES Financial Goal Setting Worksheet.

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

Living paycheck to paycheck is a reality for many U.S. workers. Nealy 1 in 4 Americans have difficulty paying bills. Financial literacy, gained through financial education helps people make informed choices about the money they have; thereby increasing financial well-being. Improving financial literacy is a national and statewide aim.

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.

Restrictions related to COVID-19 continued to present challenges for in-person programming with some partner organizations. Online delivery continued to be a significant mode of delivery for team programming. Although the virtual setting increased time management, it presents challenges for ensuring engagement and gathering evaluation information.

Training and continuing education are provided by Federal Deposit Insurance Corporation, and The Federal Reserve Bank, and finacial consumer education conferences and associations.

Skills to Pay the Bills: Career Development

Project Director

Paul Brown

Organization

Auburn University

Accession Number

7002299

Skills to Pay the Bills: Career Development

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

Skills to Pay the Bills is a statewide career development project implemented by the Financial Resource Management and Workforce Development Team. The target audience is in-school and out-of-school youth between 14 to 19 years of age. Skills to Pay the Bills is an activity-based program that helps Alabama youth develop soft skills they can use to navigate school, work and their personal lives. Eight Regional Agents taught four lessons in the "Skills to Pay the Bills" curriculum on teamwork, problem solving/critical thinking, communication, and enthusiasm and attitude. Agents presented lessons as a series and individually. The activity-based program reached 1,308 youth & young adult 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.

Agents conducted 109 activities and reached 1308 participants in 6 counties. The curriculum was implemented primarily in-person by seven (6) financial resource management and workforce development (FRMWD) regional extension agents. Lessons were offered both in a series and as individual workshops. The program was offered at various high schools and learning academies. Attendees were encouraged to complete an Extension prep/post evaluation. A sub-population of completed evaluations revealed:

- 41 participants across 2 counties received education on communication skills
- 223 participants across 9 counties received education on teamwork
- 275 participants across 11 counties received education on problem solving & critical thinking
- 151 participants across 10 counties received education on enthusiasm & attitude

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

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.

There were significant increases in knowledge about workforce interpersonal skills in four areas: communication skills, teamwork, problem solving & critical thinking, enthusiasm & attitude.

Improvements to teamwork skills include 41.2% increase knowledge in ability to demonstrate actions that show a positive team spirit, recognize my individual strengths and needs regarding teamwork, understanding of team roles and the importance of each role, importance of teamwork to job success, and the ability to recognize barriers to successful teamwork.

Improvements to problem solving and critical thinking skills include a 61% in increase ability to demonstrate ethical decisions on the job, and to recognize effective teams might address problems. A 57% increase in ability to recognize the difference between criticism, praise, and feedback and in ability to consider different perceptions and make proactive decisions based on those perceptions was also observed. Lastly 49% improved their understanding that problem solving, and critical thinking is the ability to use knowledge, facts, and data to effectively solve problems as a result of the workshop.

A 36% improvement to enthusiasm & attitude skills was seen on youth; specifically, increases in ability to demonstrate actions that show a positive attitude, recognize when my actions demonstrate a negative attitude, and accept that failure is a part of life were seen. 38% gained an understanding that attitude is viewed by many employers the #1 factor in getting or losing a job.

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

Developing soft skills is an important part of healthy adolescent development. Three fourths of employers say the incoming workforce is unprepared for the job market and lack adequate work ethic. Eighty-eight percent of managers say new hires need a strong work ethic to succeed. Soft skills help individuals to develop traits such as character, confidence and caring and provide a foundation for individuals to grow and live as productive members of the workforce and society.

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.

Restrictions related to COVID-19 continued to present challenges for in-person programming with some partner organizations, particularly schools and learning academies. Online delivery continued to be a significant mode of delivery for team programming. Although the virtual setting increased time management, it presents challenges for ensuring engagement and gathering evaluation information.

The National Council for Workforce Education conference and/or workshop attendance would provide continuing education for agents delivering workforce education, enabling them to stay abreast of the everchanging landscape. The National Association of Colleges and Employers Standards on Career Readiness: Competencies for a Career-Ready Workforce are also a useful resource.

Successful Aging Initiative

Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002376

Successful Aging Initiative

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

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 equivalent of two Urban Regional Extension Agents conducted 136 activities that included virtual and face-to-face classes, 5 workshops, 2 Drive-Up events, 12 senior Grab-Bag events, 2 events for emergency preparedness kits distribution, 4 assistive devices resource distributions, Estate Planning Clinics, and 19 events for Estate Planning document distribution. Approximately 5,330 individuals were reached. The Consumer Education for Seniors curriculum was used. The lessons were taught within a series or as standalone lessons. The curriculum focused on addressing issues relative to aging. Included were topics on Fall Prevention, Fraud and Scams, Spending and Saving Plans, and Healthy Aging. Workshop topics included Medicare, Retirement, Caregiving, Stress, Conflict Resolution, Healthcare Insurance, etc. The resource bags and grab bags

included printed information covering topics relative to aging, cognitive activities, and supplies or items used to address challenges related to aging (e.g., grabbers, sock aid, first aid kits, touchless thermometers, etc.). More than 40 new partnerships were established with community stakeholders.

Comparison of the pretest and posttest results of participants of the program indicated a statically significant percentage change/increase in their understanding or knowledge of the following:

Fraud & Scams (n = 94)

• different ways or techniques used to steal one's identity (36 %)

• things they can do to protect their identity from being stolen (37%)

• things they can do to reduce their chances of being scammed (31%)

• how to report fraud (37%) Falls (n = 78)

• age-related changes that increase their risk of falling (35%)

• behavior and choices that increase their risk of falling (34%)

• how to identify fall hazards within the home (41%)

• at least five ways to decrease their chances of falling inside the home (38%)

Healthy Aging (n=156)

• what is healthy aging (29%)

• the importance of anticipating problems, needs, or changes related to aging before they happen (142 %)

• identifying age-related stressors that impact their quality of life (84%)

• the number of participants who will start planning for aging (69%)

• the number of participants who will start planning ways to reduce, prevent or eliminate age-related stressors (43%)

The mean score for participants' overall knowledge more than doubled for understanding the importance of being proactive about aging.

Spending Plan (n = 86)

• how to write SMART financial goals (62%)

• how to track spending (71%)

• how to create a spending plan (64%)

• how to use a spending plan (69%)

• the importance of including saving within their spending plan (68%)

Estate Planning Basic (n = 130)

Based on the posttest results, only 15% of the participants had Last Will and Testament, 10% had a Living Will, and 32% had organized their important papers. After participating in the program:

• 91% understood the importance of having a Last Will and Testament

• 91% understood the importance of having a secure place for important papers

• 89% understood the importance of having an organizer or checklist for identifying and locating important papers

• 85% understood the importance of having a Living Will

• 84% understood the importance of having a Health Care Proxy

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

More than three months after participating in the program, participants continued to use the knowledge and skills gained from the program. Based on results from the delayed postassessment (n = 70), the target audience was:

• identifying signs of identity theft/fraud or scams (100%)

• paying closer attention to age-related changes that increase the likelihood of falling (98%) • using various strategies to protect their identity (97%)

• tracking their spending (96%)

• identifying and changing things in their home and surrounding environment to decrease their chances of falling (91%)

• use cost-cutting strategies to save money (91%)

• using a written spending plan (87%)

• writing out their financial goals (86%)

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

Although approximately 5,330 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 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.

Because 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 cost of public assistance.

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.

Due to restrictions placed on meeting face-to-face, a major change has been implementing and evaluating the program online. This has posed a problem with the number of individuals completing the evaluation instruments. Online programming and evaluations presented a problem for many limited resource individuals. Many program participants do not have the necessary broadband width or do not have the technology needed to access the classes. This has posed not only an access problem, but it has also posed a problem with obtaining evaluation data. Many of the activities had to be developed for easy and safe pick up of materials and supplies and some use of Zoom and audio conferences.

The results and outcomes of this program are disseminated to communities of interest by:

• ACES' annual reports

• ACES-AAMU's Urban Difference Report

• ACES' website • ACES' Facebook page

• ACES Administrators' written and verbal reports to local, state, and national officials

• Urban Regional Extension Agents' written and oral reports to community stakeholders

Financial Literacy In Progress

Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002342

Financial Literacy In Progress

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

Issue: The median income of families, over the past two years, has fallen by 3% yet the cost of living has risen by 7%. Inflation and other factors add to the already escalating debt of many households. As in other parts of the U.S., the inflation rate in Alabama is the highest seen in nearly 40 years. While lower-income, higher prices, and debt have nearly wiped out many household budgets, the number of individuals and families struggling financially to meet basic needs increases.

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

The equivalent of two Urban Regional Extension Agents conducted 99 activities that included virtual and face-to-face classes in both English and Spanish, 2 workshops, 2 grab bags events, 2 events for disaster preparedness kit distribution, and 2 money tracker distributions. Approximately 1,745 individuals were reached. The Financial Literacy in Progress curriculum was used. The lessons were taught within a series or as standalone lessons. The curriculum focused on addressing issues relative to personal finance. Included were topics on planned buying decisions, Spending and Saving Plans, banking, predatory lending, and credit. The resource bags and grab bags included printed information covering topics relative to finance, cognitive activities, and supplies or items used to address challenges related to personal finance (e.g., money trackers, spending plan worksheets, organizers, etc.). More than 40 new partnerships were established with community stakeholders.

Comparison of the pretest and posttest results of participants of the program indicated a statically significant percentage change/increase in their understanding or knowledge of the following:

Planned Buying Decisions (n = 146)

• buying behaviors that negatively impact the budget (191%)

• the impact of buying for others to see or to show status (101%)

• how to make financial decisions less impulsively and more deliberately (86%)

• where to obtain unbiased product information for making financial decisions (97%)

The mean score for participants' overall knowledge more than doubled for understanding the negative impact of certain purchasing behaviors on the budget and the effect of purchasing items for status.

Credit (n = 156)

• request a credit report (87%)

• determine what make up their credit score (92%)

• build and maintain good credit (99%)

• how predatory lending creates debt traps (131%)

The mean score for participants' overall knowledge more than doubled for understanding how predatory lending practices create debt traps.

Banking (n =79)

• how banks and credit unions work (58%)

• how different accounts work (55%)

• how interest is calculated and added or subtracted from accounts (59 %)

• compare interest rates and fees to determine the best deals (63%)

Spending Plans (n = 123)

• write SMART financial goals (89 %)

• track spending (68%)

• identify financial leaks (102 %)

• create a spending plan (80%)

• use a spending plan (99%)

The mean score for participants' overall knowledge more than doubled for understanding how to identify financial leaks.

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

More than three months after participating in the program, participants continued to use the information and skills gained from the program. Based on results from the delayed postassessment (n=98), the target audience was:

• using the decision-making process when buying large or expensive items (82%)

• researching large, expensive items before making purchases (85%)

• using a spending plan (85%)

• tracking their spending (91%)

• planning their saving (89%)

• finding ways to reduce their expenses (91%)

• requested their credit report (43%)

• reduced their use of predatory lenders (52%)

• using SMART goals to help save (65%)

• avoid making purchases based on what others think or how they see them (69%)

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

Although approximately 1,745 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 wellbeing of families and the overall performance of the U.S. economy. Unmanaged debt can deplete a family's wealth. Because 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 contribute 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 their 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 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 stressrelated health issues, leading to healthier families 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.

Due to restrictions placed on meeting face-to-face, a major change with the program has been implementing and evaluating the program online. This has posed a problem with the number of individuals completing the evaluation instruments. Online programming and evaluations presented a problem for many limited resource individuals. Many of the program participants do not have access to the necessary broadband width, or they do not have the technology needed to access the classes. This has posed not only an access problem, but it has also posed a problem with obtaining evaluation data. Many of the activities had to be developed for easy and safe pick up of materials and supplies and some use of Zoom and audio conferences.

The results and outcomes of this program are disseminated to communities of interest by:

• ACES' annual reports

• ACES-AAMU's Urban Difference Report

• ACES' website

• ACES' Facebook page

• ACES Administrators' written and verbal reports to local, state, and national officials

• Urban Regional Extension Agents' written and oral reports to community stakeholders

Helping Youth Promote Empathy- Bully Prevention

Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002445

Helping Youth Promote Empathy- Bully Prevention

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

Bullying is an insidious problem among students particularly in elementary schools all over the country. In fact, 20 percent of school students in the United States report having been recently bullied. Research over the years has shown that bullying behavior puts both student victims and the bullies themselves at increased risk for criminal behavior, delinquency, violence,

substance abuse, depression, self-harm, suicide and life-long health problems. HYPE provides an avenue for helping youth understand and using strategies to combat bullying behaviors as well as treating others the way they want to be treated.

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.

HYPE was implemented using face-to-face, hybrid and an online approach via Zoom and Nearpod. Nearpod is an online tool that allowed our UREAs to use slide-based teaching both in the classroom and remotely. UREAs used the HYPE Curriculum to create four different interactive lessons that allowed youth to engage and learn via their device or a single screen in their own classroom. Each session lasted one-hour in length with follow up questions and an evaluation. Students' responses to the evaluation were placed into graphs and charts for a clear snapshot of the learning outcomes.

After the program, 93% of youth participants were able to identify the types of bullying (cyber, social, verbal and physical); 86% believed they can combat bullying, and 42% reported belief that bullying and violence impacted their mental health.

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

Youth who participated in the HYPE series increased their knowledge of bullying and bullying behaviors. In addition, youth learned self-regulation skills and how to identify feelings of others and understand that feelings can change.

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

HYPE provides an avenue for helping youth understand and using strategies to combat bullying behaviors as well as treating others the way they want to be treated. Youth who are equipped with the skills, knowledge and strategies for dealing with bullying are less likely to become bullies, experience depression, or engage in criminal or violent behaviors.

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 COVID-19 pandemic has interrupted programming at a number of sites. Therefore, it has been challenging to engage youth in all urban areas. However, the use of Nearpod has been a resource to reach some youth during school hours.

Publications from the Alabama Cooperative Extension System (More in Our Cities) highlights the impacts of HYPE. The publications are disseminated via social media, the ACES website as well as printed materials.

Parent-Child Reading Enhancement Program

Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002378

Parent-Child Reading Enhancement Program

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

In 2019, the average reading score of grade four students in Alabama, according to the National Assessment of Educational Progress, was below the national average. 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.

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 equivalent of two Urban Regional Extension Agents conducted 19 activities that included virtual and face-to-face classes, 4 workshops, and 3 grab bag events. Approximately 455 individuals were reached. Activities taken from Florida's Center for Reading Research were used to help implement the program. The lessons were taught within a series or as standalone lessons. The materials focused on the five components of reading. Included were phonemic awareness, phonics, vocabulary, comprehension, and fluency topics. The grab bags included printed information covering topics relative to teaching reading, cognitive activities, and supplies or items used to address challenges related to reading.

Comparison of the pretest and posttest results of participants (n =92) of the program indicated a statically significant percentage change/increase in their understanding or knowledge of the following:

• the five components of reading (139**%**)

• how to use the five components of reading when teaching a child to read (115**%**)

• the purpose of phonemic awareness in teaching reading (56**%**)

• the purpose of fluency in teaching reading (13**%**)

• the goal of comprehension when teaching reading (23**%**)

The mean score for participants' overall knowledge more than doubled for understanding the five components of reading and how to use them when teaching children to read.

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

More than 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 postassessment (n=87), the target audience was:

• using the five components of reading to help teach children to read (86**%**)

• using strategies learned in the program to teach reading (88**%**)

• seeing improvement in children's reading ability (85**%**)

• seeing improvement in their ability to teach reading (84**%**)

• increasing the amount of time spent reading with children (76**%**)

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

Although approximately 455 individuals benefitted directly from the program, the broader public also benefits from the program outputs in the following way:

• Because reading proficiency in the fourth grade is a strong indicator of high school dropout, improving adults' ability to teach children how to read can impact children's ability to read. And increasing children's ability to read will impact high school dropout rates. Reducing dropout rates 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.

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.

Due to restrictions placed on meeting face-to-face, a major change has been implementing and evaluating the program online. This has posed a problem with the number of individuals completing the evaluation instruments. Online programming and evaluations presented a problem for many limited resource individuals. Many program participants do not have the necessary broadband width or do not have the technology needed to access the classes. This has posed not only an access problem, but it has also posed a problem with obtaining evaluation data. Many of the activities had to be developed for easy and safe pick up of materials and supplies and some use of Zoom and audio conferences.

Results have been disseminated using the following outlets:

• ACES' annual reports

• ACES-AAMU's Urban Difference Report

• ACES' website

• ACES' Facebook page

• ACES Administrators' written and verbal reports to local, state, and national officials

• Urban Regional Extension Agents' written and oral reports to community stakeholders

Promoting Readiness for Employment Possibilities

Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002377

Promoting Readiness for Employment Possibilities

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.

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 equivalent of two Urban Regional Extension Agents conducted 54 activities that included virtual and face-to-face classes, 4 workshops, 3 disaster preparedness events, and 1grab bag event. Approximately 595 individuals were reached. The Promoting Readiness for Employment Possibilities Toolkit was used. The lessons were taught within a series or as standalone lessons. The Toolkit focused on addressing issues relative to unemployment. Included were topics on job search, job applications, interviewing, resume building, and soft skills. The resource bags and grab bags included printed information covering topics relative to obtaining employment, cognitive activities, and supplies or items used to address challenges related to work.

Comparison of the pretest and posttest results of participants (n = 140) of the program indicated a statically significant percentage change/increase in their understanding or knowledge of the following:

• what soft skills are (79%)

• how to complete an online job application (17%)

• how to answer questions appropriately during a face-to-face interview (2%)

Comparison of the pretest and posttest results of participants (n = 140) of the program indicated a statically significant percentage change/increase in their belief about their skills and abilities relative to the following:

• interview skills (36%)

• ability to choose an appropriate attire for an interview (28%)

• job search skills (22%)

• soft skills (24%)

• ability to complete a paper job application (35%)

• ability to complete an online job application (47%)

• ability to write or revise their resume (45%)

Based on the pretest and posttest results, there was a 120% increase in the percentage of participants having a resume. The percentage of participants having a resume at the end of the program more than doubled.

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

More than 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 postassessment (n = 25), the target audience was able to:

• revise the resume created in the program to make it more appealing to potential employers (63%).

• create new resumes (64%).

• use their resume to obtain employment (72%).

• complete a job application (76%).

• complete an online job application (80%).

• use the skills learned in the program to answer questions appropriately in a face-to-face interview (88%).

• use the skills learned in the program to choose the appropriate attire for an interview (80%).

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

Although approximately 595 individuals benefitted directly from the program, the broader public also benefits from the program outputs by:

• 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.

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.

Due to restrictions placed on meeting face-to-face, a major change has been implementing and evaluating the program online. This has posed a problem with the number of individuals completing the evaluation instruments. Online programming and evaluations presented a problem for many limited resource individuals. Many program participants do not have access to

the necessary broadband width, or they do not have the technology needed to access the classes. This has posed not only an access problem, but it has also posed a problem with obtaining evaluation data. Many of the activities had to be developed for easy and safe pick up of materials and supplies and some use of Zoom and audio conferences.

The results and outcomes of this program are disseminated to communities of interest by:

• ACES' annual reports

• ACES-AAMU's Urban Difference Report

• ACES' website

• ACES' Facebook page

• ACES Administrators' written and oral reports to local, state, and national officials

• Urban Regional Extension Agents' written and verbal reports to community stakeholders

Successful Aging Conference

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002380

Successful Aging Conference

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, economic system, the job market, and nearly all aspects of 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.

The equivalent of two Urban Regional Extension Agents conducted 14 activities that included 5 virtual conferences, 2 Drug Takeback, 4 Drive-Thru events, 1 E-Waste Collection, 1 Flu Vaccine Clinic, and 1 Document Shredding event. Approximately 1,145 individuals were reached. The conferences included topics on "Combating Loneliness & Isolation," "Increasing Physical Activity for Healthier Living," "Vaccine Education," "Aging Humor," "Money Management," "Consumer Protection," "Future Planning," and "Healthcare. "Resource bags (approximately 1,000) included printed information covering conference topics, cognitive activities, and supplies or items used to address age-related challenges. Some of the items included were grabbers, alert device, sanitization kit, exercise resistance bands, grocery caddies, and a screwdriver with multiple heads and flashlight. Approximately 147 pounds of unused drugs were removed from homes and safely disposed of. A total of 500 pounds of e-waste and 1,540 pounds of unwanted paper were removed from homes and safely disposed of.

Based on posttest results of the conference presentation on Money Management (n = 23),

• the information provided was extremely useful in helping participants (87%) address everyday issues and concerns relative to money.

• participants' (65%) knowledge of money management increased significantly.

• participants' (78%) knowledge of available resources to help manage their money increased significantly.

Based on posttest results of the conference presentation on Consumer Protection (n = 33):

• 100% indicated that the information provided was either extremely useful or very useful for addressing their everyday issues and concerns regarding consumer protection.

• 70% indicated that their knowledge of reducing their chances of getting scammed increased significantly.

• 82% indicated that their knowledge of services available to help protect them from being scammed increased significantly.

Based on posttest results of the conference presentation on Future Planning (n = 18):

• 100% of the participants indicated that the information provided was either extremely useful or very useful for addressing their everyday issues and concerns regarding future planning.

• 67% of the participants indicated that their knowledge of retirement planning increased significantly.

• 67% of the participants indicated that their knowledge of estate planning increased significantly.

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

Older adults (target audience) benefitted from this program in the following ways:

• 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.

• reduced chances of medication errors.

• increased vaccine education decreased stress and anxiety levels related to the COVID vaccine.

• increased ability to make informed decisions about the COVID vaccine decreases the likelihood of getting COVID.

• 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 1,145 individuals benefitted directly from the program, the broader public also benefits from the program outputs in the following ways:

• increasing individuals' ability to dispose of unused medication helps to reduce the chances of youths and other individuals' misuse of unused drugs.

• 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 scammers reduces the financial burden on 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.

• increasing the number of older adults vaccinated against COVID-19 reduces the chance of other individuals catching the virus locally, nationally, and globally.

• vaccination also reduces the number of hospitalizations and even deaths of older adults, further impacting the healthcare system and finances of families who might otherwise have to deal with loss and grief, estates, and final medical bills.

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.

Due to restrictions placed on meeting face-to-face, a significant change has been with implementing and evaluating the program online. The changes have posed a problem with the number of individuals completing the evaluation instruments. Online programming and evaluations presented a problem for many limited resource individuals. Many program participants do not have the necessary broadband width or do not have the technology needed to access the classes. Online program implementation has posed not only an access problem but has also posed a problem with obtaining evaluation data. Many activities were developed for easy and safe pick up of materials and supplies and some use of Zoom and audio conferences.

The results and outcomes of this program are disseminated to communities of interest by:

• ACES' annual reports

• ACES-AAMU's Urban Difference Report

• ACES' website

• ACES' Facebook page

• ACES Administrators' written and verbal reports to local, state, and national officials

• Urban Regional Extension Agents' written and oral reports to community stakeholders

Zoom for Seniors

Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002379

Zoom for Seniors

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

The CDC (2020) and the National Coalition on Mental Health and Aging ([NCMHA], 2020) note that loneliness and social isolation in older adults are serious public health issues that can put older adults at a higher risk for dementia, heart disease, mental health issues, and other severe medical conditions. The demand for older adults to socially distance and health concerns related to such actions have caused many individuals, families, and organizations to seek ways to keep individuals, especially seniors, connected. One of the many strategies is the use of electronic communication platforms.

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 equivalent of two Urban Regional Extension Agents conducted 12 activities. Approximately 189 individuals were reached. The lessons were taught within a series. The material focused on helping participants gain the knowledge and skills needed to start using Zoom quickly. Included were topics on how to schedule meetings/sessions, send invites, host a meeting/session, share screen, respond using chat or reaction buttons, join sessions and leave sessions. One-on-one sessions were held prior to and after joining the classes. With each lesson, handouts were provided with step-by-step instructions.

Comparison of pretest and posttest results of participants (n = 75) of the program indicated a statically significant increase in their knowledge of how to:

• participate in Zoom sessions
• host a Zoom session
• use Zoom to stay connected with family and friends

Comparison of pretest and posttest results of participants (n = 75) of the program indicated a statically significant increase in their ability to:
• participate in Zoom sessions
• host a Zoom session
• use Zoom to stay connected with family and friends

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

The target audience benefitted from this project by avoiding being socially isolated from family and friends. They were able to continue with many of their social activities during the lockdown using Zoom. They were not only able to participate in Zoom sessions, but they were also able to create and host activities through Zoom.

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

Although approximately 189 individuals benefitted directly from the program, the broader public also benefits from the program outputs in the following way:

• older adults' ability to use Zoom during the lockdown allowed family and friends to see, interact and stay connected with loved ones.

• such actions helped family and friends mentally as well as socially.

• pastors, employers, friends, colleagues, children can continue providing social and emotional support to loved ones even when they cannot meet in person.

• using Zoom, social organizations and employers benefit from older adults' ability to maintain their positions (paid or volunteer service).

• participants' knowledge of how to use Zoom helped ease stress, fear, and anxiety for many of their children and grandchildren, thereby preventing health-related issues.

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

One problem for many limited resource individuals was limited broadband access. Many of the participants of this program do not have access to the necessary bandwidth needed to maintain an effective connection with the classes.

The results and outcomes of this program are disseminated to communities of interest using the following outlets:

• ACES' annual reports

• ACES-AAMU's Urban Difference Report

• ACES' website • ACES' Facebook page

• ACES Administrators' written and verbal reports to local, state, and national officials

• Urban Regional Extension Agents' written and oral reports to community stakeholders

Extension, Education, and Research Track (EXERT)
Project Director
Raymon Shange

Organization
Tuskegee University
Accession Number
7002768

Extension, Education, and Research Track (EXERT)

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

An alarming number of young children and teens are disconnected from the mainstream of our society. They have been labeled "at risk" because of the harsh realities of their lives. If these young people remain disconnected, we will lack the skilled, motivated workers to sustain our economy. We will have denied these young people the chance to lead healthy, fulfilling, productive 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.

Weekly meetings (August through February) with students in order to educate them on Character Development and presenting topics in STEM, Nutrition and Obesity, as well as community development and personal finances. The Exert Competition was a one-day event culminating in the application of these same type of skills that some have gained through TUCEP educators throughout the year. The virtual EXERT Camp was held in the summer further establishes these hallmarks of character, citizenship, and STEAM through team-building activities, agricultural/planting activities, hiking & tree identification, art, reading, writing and reflection, swimming fishing and other recreation.

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

Results indicated that of the 311 students participating in the EXERT program throughout the year that 88% of all of the students reported that they had increased their knowledge of Sciences (including basic science, tools of science, and scientific method), while 90% reported increases in their ability to apply science (includes agriculture, engineering, design, culinary arts, etc.). Participation in the program decreased substantially due to the pandemic.

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

The benefits of this program go beyond just the individual students, as the broader impacts can be seen in their families and communities. This program overlaps with the state curriculum being taught in classrooms throughout the Black Belt, and results from a collaboration with the teachers and schools. Families are given needed educational assistance through programming for their children to increase their chances of success in the future.

Alabama 4-H CS Pathway

Project Director
Mary Gregg
Organization
Auburn University
Accession Number
7002234

Alabama 4-H CS Pathway

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

Alabama youth, like many others, had been in front of their computers screens an inordinate amount of time during the 2020-2021 school year due to the global pandemic. Studies show that many youth and teens have had a tough time coping emotionally with the pandemic, remote schooling, and an absence of social activities. However, computer science education is a much needed 21st century skill that many school systems are challenged to bring to their students.

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 National 4-H CS Pathways program was a short grant opportunity (April 2021 – September 2021) with big impact.

- Summer Day Camps: 269 youth with 1 – 2 hours of CS experience
- 4-H Clubs: 77 youth with 2-4 hours of CS experience
- Military partnerships: 57 youth with more than 6 hours of engagement in afterschool and day camp programs
- Overnight STEM Camp: 42 youth in programs led by 23 teen leaders
- CS school enrichment: 396 youth in 6th – 12th grades
- CS Afterschool programs: 200 youth in underserved communities
- 4-H Day at McWane classroom sessions: 26 youth, 11 adults, and 3 teen leaders

Increasing diversity and underrepresented groups by engaging girls, minority youth, military youth, and rural youth (per RFA):

- 41 Hispanic youth
- 43% minority youth
- 57% female youth
- 65% rural youth
- 57 military youth

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

With CS Pathways funding through National 4-H, Alabama 4?H put together CS-in-a-Box program kits designed to connect youth to computer science and STEM through unplugged outdoors activities. The CS-in-a-Box Program Kits contained program materials designed for youth to engage their Head in coding experiences, their Heart in positivity and mindfulness through icebreaker activities, and their Hands in unplugged computer science outdoors, providing a 4?H experience that contributes to improved Health. The kit included OzoBots, which offers youth a computer science experience both on and off a computer. These kits were used along with previously obtained Chromebook kits, the 2021 4-H STEM Challenge kits, and 4?H CS curriculum placed in each of the seven Alabama 4?H regions.

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

Computer Science education develops problem-solving and computational thinking skills, and ignites creative thinking while providing an understanding of the technology that touches every part of our lives. Schools and future employers recognize the need for skilled technology workers. Informal learning is one of many educational mechanisms that may contribute to improving STEM literacy and stimulating youth to explore STEM fields.

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.

Will will continue and expand the proram as new funding opportunites arise.

Alabama 4-H Grows Youth Gardening

Project Director
Mary Gregg
Organization
Auburn University
Accession Number
7002232

"Alabama 4-H Grows Youth Gardening"

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

As Alabama's and our nation's population moved from an agrarian/rural based society to a suburban/urban society, most of our population has become disconnected in their understanding of how and where our food is grown. Luckily, in the past few years, there has been a resurgent among some members of our society in knowing more about where our food originates such as the "farm to table" movement and with a renewed interest in "cooking" as is displayed through the variety of cooking shows that are available. The 4-H Grows Program embraces this renewed focus by providing youth with a variety of gardening projects to choose from, regardless of their own gardening experience as well as their social and economic backgrounds. This is especially important as these projects engage the youth and indirectly, their family in growing healthy vegetables while also utilizing them in their family's meals. These projects help youth to reconnect with nature while developing an understand of the importance of agriculture and how food ends up on our table. In addition, participating youth learn about a variety of career opportunities from agriculture to culinary arts which may help them find their future career.

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 the promotion of the 4-H Grows program and developing different levels/tiers of projects so that youth between the ages of 5 and 18, regardless of gardening experience or background can participate in a project, we had the following youth enrolled in the program.

- 2,496 Youth participated in one of the 4-H Grows projects.
- 789 (31.6% of participating youth) Minority youth participated in one of the 4-H Grows projects. Of the minority youth, 21.5% African American, 8.4% Hispanic, 2% Asian, and .1% Native American/Alaskan Native.
- 55% or 1,374 of the youth were female.

Flyers were created for 4-H Grows Tiers 1, 2, 3 & 4, Sweet Potato Challenge, and Container Garden Challenge to help 4-H county personnel promote the 4-H Grow Projects to their counties' youth and family audience. The fliers where shared directly with 4-H/Extension employees as well as placed on SharePoint for easy access.

Gardening journals were updated for 4-H Grows Tier I, II, III, & IV and the Sweet Potato Challenge. The journals were place on the 4-H website for easy access by youth and parents as well as placed on SharePoint for access by 4-H personnel.
The Tier IV project was developed during the summer of 2021 and implemented in August 2021. This purpose of this project is to encourage youth to grow produce for others. Participants in this program are required to donate at least 50% of the produce they grow to a local food bank or other program that helps feed those in need.
Promotional announcements were placed on social media platforms such as Facebook.
Two ZOOM meetings (one early spring and one late summer) were provided as promotional items to help communicate information pertaining to the 4-H Grows Program's projects.
During the gardening season, up to date gardening information and tips are emailed to county 4-H Staff periodically so that they can forward this information to participating youth.

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

Youth that participated in a 4-H Grows project benefited by growing their own produce from seed or transplant to a harvestable plant that they shared with their family and others. This activity gave them the satisfaction and feeling of success as they cared for a plant while keeping a journal throughout a complete growing season. It also gave them the opportunity to feel a sense of accomplishment and pride by helping others, including their family by putting food on the family's dinner table.
Through the gardening experience, participating youth learned about agricultural careers. In addition, if a participant, selected the Tier III project, he/she learned about being an entrepreneur and starting their own produce business.
Youth also developed a better understanding or where our food comes from and the dedication of our farmers that grow our food.

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

The public benefits from Alabama's youth that participate in 4-H Grows through the following ways:

- Through our youth becoming more knowledgeable about gardening, they help to educate others about gardening and the importance of understanding where and how food is put on our dinner tables.

- Many of our youth donate produce that they have grown to local food banks and other such organizations that help feed those that are less fortunate.

- Some of our youth have gardens in public areas such as at schools or at their local Extension office. These gardens are viewed by the general public which helps to promote the concept of gardening at home.

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.

Covid 19 protocols within schools and throughout the community has greatly affected the use of the 4-H Grows Program within K-12 public and private schools. Many schools were not willing to commit to the gardening program being done on campus during this time due to the possibility of having to go virtual and hurdles faced by educators at this time.
Another obstacle has to do with making sure that the 4-H Grows Program is promoted at each of Alabama's 67 counties since this does need to be a county initialed program.

There are several opportunities for Extension personnel to receive training and professional development in the 4-H Grows Program.

- A program overview ZOOM training is provided at least twice a year, one in early spring that targets the spring/summer gardening projects and the other one taking place in August for the fall/winter gardening projects. These meetings are

recorded and shared as needed.

- Upon request, training can be made available at the county level to Extension personnel.

- Gardening videos and informational information is available to Extension personnel.

During the coming program year, a new project will be introduced that combines wildlife and gardening over a two-year period. This project will focus on growing birdhouse gourds during year one and then setting up and monitoring a purple martin nesting site during year-two.

During the coming year, several 4-H Grows specific videos will be created for youth and 4-H personnel. The purpose of these videos will be to help provide training and “how to” information throughout the project.

Alabama 4-H Natural Resources and Environmental Education

Project Director

Mary Gregg

Organization

Auburn University

Accession Number

7002231

"Alabama 4-H Natural Resources and Environmental Education"

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

Alabamians should recognize our natural resources as state treasures and advocate for their sound management and protection. Unfortunately, Alabamians regularly place a very low priority on environmental protection. Low environmental literacy and decreased time spent outdoors contribute to a lack of knowledge of our resources and the role that citizens may play. We are currently 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.

4-H natural resources and environmental education program outputs include the implementation of 7 aquatic education workshops (Aquatic WILD, AWW, Sportfishing, RiverKids), 6 forestry and wildlife workshops (Project WILD, WHEP, Forestry), 2 forestry and wildlife statewide competitive events, 1 statewide virtual fishing contest, 33 live animal outreach programs; and statewide delivery of education and outreach programs in schools, with community clubs, through special events, enrichment activities, and through science school visiting groups. Through successful partnerships, in-kind donations, and grant funds we were able to distribute 100 fishing rods and reels, 16 water test kits, a new set of kayaking PFDs, and develop 5 curriculum pieces. We conducted 13 professional development opportunities for ACES personnel concerning forestry and wildlife, aquatic education, and also club development for competitive teams. Some of these opportunities were open to volunteers and partners that work with ACES personnel as well. In addition, we provided continuing education to RiverKids Instructors for risk management certifications in CPR, Wilderness and Remote First Aid Training, and Paddlesports Safety.

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

As result of our natural resource and environmental education programmatic efffort, we were able to reach approximately 29,036 participants and provide exposure to learning about Alabama's natural resources. This included certifying 37 youth as water chemistry monitors, collecting 53 citizen science records, paddling 77 miles of Alabama freshwater in 11 different

bodies of water, certifying 9 kayaking instructors, certifying 15 fishing/aquatic education instructors, certifying 15 Aquatic WILD educators, certifying 25 Project WILD educators. Further, it enabled participants to develop a stronger sense of water safety, stewardship, and aquatic recreation skills.

Our target audience benefited from our outputs by way of program support and materials, capacity building, educational lessons and curriculum, citizen science engagement, gains in confidence, and increases in knowledge and behavior. For example, 100% percent of surveyed participants could correctly define personal flotation device (PFD) and knew that it should not be loose enough to pull over your head. One hundred percent also indicated that water quality affects human health and the environment. Participants demonstrated a 60 % increase in water knowledge and a 67% increase in confidence in kayaking skills. Lastly, a 60% increase in natural resources related careers was generated.

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

4-H natural resources and environmental education outcomes are indicative of our efforts to reach and educate youth about Alabama's natural resources and engage them in outdoor experiential learning, as well as a demand from our audience for these types of opportunities. The citizen science engagement work resulted in increased knowledge of water quality in the state. Ultimately, our programmatic reach equipped youth and adults with the necessary tools to be stewards of our state's resources which supports the public interest.

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 our programming. Alabama's drought and flood conditions affected ability to utilize waterways for program activities and events. Further, COVID-19 greatly impacted our abilities to reach youth and educators through in-person programs and activities. 4-H natural resources and environmental education program activities will continue as planned. We will seek new funding opportunities, address grassroots needs for training and programmatic support, and aim to conduct more in-person programming as COVID restrictions allow.

Adolescent and Young Adult Experiences Leading to Persistent Alcohol Use Disorder, Depression, and Comorbid Alcohol Use Disorder and Depression in Young Adulthood

Project Director
Diana Samek
Organization
Auburn University
Accession Number
1021412

Adolescent and Young Adult Experiences Leading to Persistent Alcohol Use Disorder, Depression, and Comorbid Alcohol Use Disorder and Depression in Young Adulthood

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

Results from this study will identify which risk factors in the late adolescence and first year of college are the most relevant to a
course of problematic alcohol use that co-occurs with depression lasting through young adulthood. Given the increasing rates of

depression and substantial rates of alcohol use disorder in the population of students transitioning into and out of college, this
work is necessary and will provide subsequent guidance for successful prevention and intervention.

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.

Methods used include comprehensive survey assessment of college students as they transition in the first and second years of college as well as when they are expected to be one year post college. Comprehensive measures include everything from personality to family support, peer and romantic relationship experiences, and detailed measures of depressive and substance
use disorder symptoms. We also take advantage of pre-existing large and longitudinal data sets to evaluate these research questions more broadly in the population of adolescents as they transition into young adulthood.

The ulitmate goal is to identify individuals early on, such as in their first semester of college, who are at high risk for severe substance use problems that often co-occur with other aspects of adjustment, including depression and academic failure. Providing appropriate support tailored to these individuals at critical turning points will offset the economic, individual, family,
and community burden associated with chronic and complicated physical and mental health problems.

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

Target audiences include scholars (e.g., researchers, colleagues, students) involved in studying the development of adolescent and young adult substance use disorders and related psychopathology.

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

Major goals of the project:

Specific aim 1: To identify factors that promote or deter problematic alcohol use, depression, and comorbid AUD and depression at key turning points, including the transition into and out of college. Three waves from the College Experiences Study (N = 209) will be used to address this (data collected in the 2015-2016 and 2016-2017 academic years when participants were first and second year students, as well as in the 2019-2020 academic year, when participants are expected to be in their first year post-college).
Objective 1a: Produce preliminary data identifying salient risk factors in the first and second years of college that predict a trajectory of chronic and comorbid AUD and depressive symptoms at one year post college.
Specific aim 2: To submit a five-year R01 proposal to the National Institutes on Alcohol Abuse and Alcoholism (NIAAA). Pilot data from specific aim 1 will be used to bolster support for study hypotheses and demonstrate ability to complete the study design. Collaborations with other investigators from several colleges and universities in Alabama and elsewhere will be a priority in order to evaluate for potential differences by school features. Such features include whether schools are predominately located in rural vs. urban environments, are located in Southeast vs. Midwest (or other geographic locations), and whether they land grant universities vs. community colleges. I will also aim to follow a sample of 18-19 year-olds that are not enrolled in college (with no intention of enrolling) to better identify contextual risk
profiles of persistent AUD, depression, and comorbid AUD and depression for these groups as they transition from adolescence into young adulthood.
Objective 2a: Identification of collaborators at (at least) three colleges or universities.
Objective 2b: Securement of letters of support from respective Registrars from collaborators.
Objective 2c: Identification of a control group in populations the colleges and universities are from.
Objective 2d: Submission of a complete R01 application.
Specific aim 3: Continue to evaluate data from a large, secondary data analysis project in order to test specific hypotheses concerning risk profiles of problematic substance use and comorbid psychopathology at important developmental transitions from adolescence through young adulthood. Three waves of data from the Minnesota Twin Family Study (N=2,769) will be used to address this aim, when participants were on average 17, 24, and 29 years of age. Publications resulting from this will also bolster the PI's success for specific aim 2.
Objective 3a: Publish (at least) three papers identifying salient risk factors for chronic and comorbid AUD and depression from adolescence to yount adulthood.
What was accomplished under these goals?
Specific aim 1:
Data have been thoroughly analyzed and submitted for publication to directly address specific aim 1 and objective 1a. Results

showed those with a liability towards negative emotions and especially high levels of perceived stress in their first year of college were most likely to develop a higher level of persistent depressive symptoms over a period of ~4 years. Affiliating with antisocial or substance-using peers and greater average quantity of alcohol use in the first year of college was most relevant to a persistent course of alcohol use disorder (AUD) symptoms. Depressive symptoms and AUD symptoms were more likely to co-occur in the transition out of rather than into college.

Preliminary data was also thoroughly analyzed and tables were prepared for subsequent extramural grant applications. These results demonstrated important gender differences in the risk factors for AUD vs. depressive symptoms. For example, a liability toward negative emotions and greater perceived stress were generally more correlated with both AUD and depressive symptoms for women, but only depressive symptoms for men. This aligns with recent work demonstrating women may be more likely to use substances to cope with negative emotions and stress more than men. Given research demonstrating women are more likely to suffer from heavy or problem drinking than men, and the increasing rates of depression and anxiety in high school and college samples, these results highlight a potential public health crisis in the coming years for young women in the United States. This was the driving rationale for the submitted R01 application (described below), in which my specific aims were to identify what is driving the increase in depression and anxiety among college students, evaluate how the same or different risk factors also predict potentially co-occurring problematic substance use outcomes and evaluate how such results vary by gender and change over time (from the transition into as well as out of college).

I have also expanded on specific aim 1 by adding data collection efforts in Fall of 2021 (continuing in Spring of 2022), where I over-sample first-year students that identify as Black, Indigenous, or Other People of Color (BIPOC) at our Predominantly White Institution (PWI) in order to better understand how unique factors regarding campus climate, experiences of discrimination (including microaggressions), and other known risk and protective factors (parent support, key personality traits) work together to predict mental health and potentially co-occurring substance use problems in historicallyexcluded

vs. included populations. I am thankful for the matched funding awarded by my Associate Dean of Research and Department Head to support these efforts.

Finally, I also am expanding aim 1 with plans for further data collection in 2022. Specifically, I aim to follow up with the sample of college students involved in a romantic relationship that I originally collected data from in Fall of 2019 and Fall of 2020. This effort was initiated based on findings from my original study demonstrating romantic relationship factors seemed important to the subset of students involved in one (e.g., about 70 cases at Wave 1). This low number was underpowered to test this adequately, thus I initiated a survey for students involved in a romantic relationship specifically in a design powered to

analyze this thoroughly. With the cohort-sequential design, I am also exploring differences in pre-pandemic vs. pandemic cohort status. These efforts will support my publication record and extramural grant applications.

Specific aim 2:

Ahead of schedule, I have successfully drafted and submitted my proposed NIH application in May of 2020. I had successfully met part of Objective 2a, as I identified one collaborator at another university. I also partially met objective 2b, as I received a support letter from the AU Office of Institutional Research supporting my research study and agreeing to provide me contact information for my study population as requested. I have not yet identified a potential control group (in line with Objective 2c).

It was a major accomplishment to submit my first R01 application. Since submission, however, my external collaborator has unfortunately decided they are not interested in continuing the project. That was a shocking disappointment given the huge effort already in place. I have doubts about securing additional collaborators based on this experience, as I learned I cannot acquire access to identifying info to sample those at secondary data collection sites if collaborators suddenly decide they are not able to continue the collaboration. I have since revised my efforts at collaboration and will focus such efforts on including a senior researcher with demonstrated success in being awarded and running large R01 studies (in line with feedback received on my submitted R01 application). I will continue to work at efforts to identify a potential secondary sample

(such as recruiting high school seniors at local schools) that compliments the work I am doing with college students as they transition into and out of college.

Although my R01 was not awarded from my first submission (to be expected in this funding climate), I did receive good feedback from reviewers to consider in my next steps. I am thankful for the college and department matched funding that is supporting my current efforts in data collection to bolster the success of my next R01 application.

Specific aim 3:

Given the amount of time dedicated to my first R01 application and the need to publish data from my College Experiences Study, I did not move forward on secondary data analysis plans. Given the recent changes in depression and anxiety rates and the decoupling of AUD symptoms with such mental health challenges in the recent cohort of youth, I am not sure such analyses of the Minnesota Twin Family Study would be generalizable to the current population of adolescents and young adults. I continue to explore other secondary data analysis opportunities to build my publication record. I am looking into submitting a proposal to the NIMH to take advantage of the most recently released data from the ABCD study (see https://abcdstudy.org/scientists/data-sharing/).

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.

I have provided training to my graduate students on data management practices, software coding, statistical analysis, and publication. I have provided training to undergraduate and graduate students on recruitment practices, including professional
communication, marketing, and data base tracking.

Results have been disseminated through conference presentations and manuscripts submitted for publication. I also continue to post status updates reporting results via social media:
https://www.facebook.com/aucollegeexperiences/
https://www.instagram.com/aucoexp/
https://twitter.com/AuBeyond

As described above, I will continue data collection efforts (specific aim 1), which will bolster my success with subsequent extramural applications (specific aim 2). I will begin to evaluate the need for secondary site data collections and apply for funding to support such efforts (specific aim 2). I will continue to draft manuscripts in line with specific aims using primary and
secondary data collection (specific aim 3).

Journal Articles Submitted 2022
Samek, D.R. Predictors of persistent alcohol use disorder and co-occurring depressive symptoms: Insights from the longitudinal college experiences study. This manuscript was prepared and submitted for publication in the reporting period, but I am not expecting publication until 2022.

Journal Articles Under Review 2022
Samek, D.R. & Akua, B. Predictors and consequences of alcohol use vs. alcohol and marijuana use in college. This manuscript was prepared and submitted during the reporting period, but I am not expecting publication until 2022.

Journal Articles Awaiting Publication 2022
Dawson, M.D.R. & Samek, D.R. Parent and peer social-emotional support as predictors of depressive symptoms in the transition into and out of college. This manuscript was prepared and submitted during the reporting period, but I am not expecting publication until 2022.

Journal Articles Submitted 2022
Samek, D.R. Personality x romantic relationship interplay as predictors of alcohol use disorder and depressive symptoms in college. This manuscript was prepared and submitted during the reporting period, but I am not expecting publication until 2022.

Conference Papers and Accepted 2020
Samek, D.R. & Beckmeyer, J. (2020, November). Romantic partner relationship experiences, personality, and problematic alcohol use. Paper presented at the 2020 Annual Meeting of the National Council on Family Relations

Conference Papers and Accepted 2021
Dawson, M.R., Samek, D.R. (2021, November). College Students, positive emotionality, negative emotionality, depressive and anxiety symptoms, and GPA: A Longitudinal mediation and moderation analysis. National Council on Family Relations. Interactive poster presented at the 2021 Annual Meeting of the National Council on Family Relations.

Akua, B.A., & Samek, D.R. (2021, November). The Developmental unfolding of substance use disorders and academic achievement in the transition into and out of college. Interactive poster presented at the 2021 Annual Meeting of the National Council on Family Relations.

Changes/Problems
As described previously, my collaborator has withdrawn, which impacted my ability to collect secondary site data. I am considering the next steps on the necessity of secondary sites (perhaps instead of focusing on local high schools rather than other colleges and universities) and considering the advice from my R01 application to focus energy on including a senior investigator to guide and support my efforts rather than as a collaborator as I had originally envisioned. Lessons learned - I continue to forge ahead.

A second issue is that while efforts to publish have hit all target goals, waiting for reviews has increased substantially in time due to the ongoing global pandemic. It seems reviewing manuscripts was one of the first things to go out the window as faculty attempted to work from home and home school their children, etc. For example, after being under review for five months at one journal, a paper was desk rejected. Two other papers were under review for 6-7 months. After several attempts to identify if any progress was made on obtaining reviews or assigning associate editors, editorial staff were vague and the editor was unresponsive. I had to withdraw submission and submit it elsewhere as a result of that.

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

Project Director
Stephen Erath
Organization
Auburn University
Accession Number
1021451

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

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

Peers can be sources of critical support during the transition to adolescence; at the same time, peer experiences can cause considerable distress (Parker et al., 2006). Fears of negative evaluation from peers are among the most frequent and intense fears reported by children, and these fears increase from childhood to adolescence (Westenberg et al., 2007).

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.

Increases in selfreported social concerns in adolescence are corroborated by heightened physiological responses to social performance and
exclusion challenges in adolescence compared to childhood (Stroud et al., 2009; Sumter et al., 2010). In addition to biological and psychological changes that contribute to peer stress, children often move from smaller elementary schools to larger middle
or junior high schools with more expansive peer groups around the transition to adolescence. Such transitions are often characterized by peer competition for social status, and thus aggressive behavior increases (Eccles et al., 1998; Pellegrini & Bartini, 2000) and rates of exclusion and peer victimization rise (Wang et al., 2009; Shell et al., 2014).

Almost all early adolescents occasionally feel anxious about peer evaluation or experience exclusion or rebuff from peers. Whether these normative peer stress experiences intensify and contribute to psychological maladjustment may depend, in part,
on involuntary physiological and voluntary coping responses to stress. However, physiological and coping responses are understudied potential risk or protective factors in the context of peer stress. Study 1 will examine how physiological and coping
responses predict social and psychological adjustment and moderate longitudinal associations between peer stress experiences and social and psychological adjustment.

A salient form of peer stress in early adolescence is peer victimization--being targeted with physical, verbal, relational, or cyber
aggression (Card & Hodges, 2008). The majority of early adolescents experience peer victimization at least periodically, and approximately 15% are systematically bullied by more socially or physically powerful peers on a regular basis (Farrell et al., 2007; Nansel et al., 2001; Wang et al., 2009). Even in school and community samples, peer victimization experiences are linked with same-day increases in anxiety, humiliation, and anger (Nishina, 2012; Nishina & Juvonen, 2005), as well as physiological responses indicative of distress in peer stress situations (Erath et al., 2012; Kliewer et al., 2012). Peer victimization also predicts
increases in internalizing (Reijntjes et al., 2010; Zwierzynska et al., 2013), externalizing (Reijntjes et al., 2011), and academic (Juvonen et al., 2011; Nakamoto & Schwartz, 2010) problems over time.

Despite the substantial psychological and academic costs and the nearly unanimous recommendation that children should tell
their parents if they are victimized, very few studies have examined how parents can help early adolescents with peer victimization specifically (Lovegrove et al., 2013). Indeed, we have almost no direct scientific evidence about whether or what types of parental responses to peer victimization (PRPV) improve or undermine social and psychological adjustment. Study 2 will examine concurrent and prospective relations between PRPV and early adolescents' coping responses to peer victimization
(e.g., problem-solving), social adjustment (e.g., peer acceptance), and psychological adjustment (e.g., depressive symptoms).

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

Children and their parents and teachers are the target audience. We need to analyze additional data before disseminating practical information to the public. Project methods and results have been discussed in undergraduate and graduatelevel courses.

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

The overarching goal of the proposed research is to identify child and parent responses to peer stress that protect against social and psychological maladjustment. The first objective is to examine how children's physiological and coping responses predict social and psychological adjustment and moderate longitudinal associations between peer stress experiences and social and psychological adjustment. The second objective is to examine concurrent and prospective relations between parental responses to peer victimization and children's coping responses to peer victimization (e.g., problem-solving), social adjustment (e.g., peer acceptance), and psychological adjustment (e.g., depressive symptoms).

During the reporting period, we continued to code and analyze data and publish papers related to the project goals. Publications focused on parenting and child responses to peer stress as related to social and psychological 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.

The current project is providing opportunities for undergraduate and graduate students to gain hands-on training in protocol design, multi-method data collection, and human subjects protection. Several graduate students are using data from the project for theses or dissertations, and more students will use project data in the future. Data stemming from the project will continue to provide opportunities for graduate students at Auburn University to present findings at major professional conferences and to be involved in manuscript preparation and publication.

To date, the results have been disseminated to the scientific community, and we will disseminate information about the practical significance of the results in the future.

We will continue to seek external funding to further accomplish the goals of the current project. We will also continue to analyze data and publish manuscripts that address the goals of the current project.

Journal Articles Published 2021
Erath, S. A., & Troop-Gordon, W. (2021). Social-contextual predictors of early adolescents' responses to peer victimization: Introduction to the special issue. Journal of Early Adolescence, 41, 5-12.

Tu, K. M., Erath, S. A., Pettit, G. S., & Vandenberg, C. (2021). Parents' responses to peer victimization: Associations with early adolescent coping and peer victimization. Journal of Early Adolescence, 41, 167-196.

Erath, S. A., Pettit, G. S., & Troop-Gordon, W. (2021). Direct and compensatory parental responses to peer victimization. Journal of Early Adolescence, 41, 197- 217.

Zeringue, M. M., Erath, S. A., & El-Sheikh, M. (2021). Exposure to peer aggression and adolescent sleep problems: Moderation by parental acceptance.
Journal of Family Psychology, 37, 897-905.

Using Deviance Regulation Theory to Combat Bullying

Project Director

Wendy Troop-Gordon

Organization

Auburn University

Accession Number

1017585

Using Deviance Regulation Theory to Combat Bullying

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

Raising healthy, well-education children is vital to our country's economy and prosperity. Bullying puts the goal of raising healthy children at risk. Bullying jeopardizes children's psychosocial development, academic engagement, and educational success. To name only a few of the outcomes that have been associated with bullying, youth who are bullied are at increased risk for psychological distress, somatic complaints, sleep disturbances, obesity, truancy, suicidal behaviors, self-injury, and academic failure. Thus, finding effective means of reducing bullying and creating supportive, safe school environments has become a top concern of educators and psychologists.

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.

One of the most effective ways of reducing bullying and peer victimization (i.e., being the repeated target of other's bullying) is to increase the number of bystanders who are willing to stand up for victims (i.e., engage in defending behaviors). To this end, a number of programs have been developed with this aim. However, these existing programs are timely, costly, and only moderately effective. Schools need cost-effective intervention activities that can be readily implemented by school staff within a reasonable time frame. The goal of this project is to increase defending behaviors among late elementary school and early middle school students using an intervention from health psychology that has been shown to be effective in increasing health-related behaviors. Drawing on principles from Deviance Regulation Theory (DRT), the intervention motivates behavior by linking the behavior to being viewed positively by peers. Late childhood and early adolescence are a perfect time for trying this approach to increasing defending behaviors, as children at these developmental stages are highly concerned with how they are viewed by others, especially friends and classmates. The intervention requires only 55 minutes (one ten-minute session in which children provide a list of words which they believe best describe children who stand up for kids when they are bullied and one 45-minute session in which they learn about the postive words used by their agemates to describe defenders, talk about effective ways to engage in defending, and make posters explaining what they have learned to younger schoolmates). Thus, this is a simple, but potentially, effective means of increasing defending behaviors. Two studies will be conducted to test this approach. Study 1 tests the intervention in over 70 4th-grade and 5th-grade classrooms in 13 elementary schools. Half of the schools are randomly assigned to participate in the DRT-based intervention, and the other half receive a more traditional intervention activity aimed at increasing defending. The interventions are conducted mid-Fall, allowing ample time for growth in defending behavior and subsequent decreases in bullying and bullying-related problems. Questionnaires are collected two weeks before the intervention, in the winter three months after the intervention, and in the spring six months after the intervention. Participating students and their teachers complete questionnaires at all three time points, allowing for a highly comprehensive assessment of the intervention's effectiveness. Study 2 will be conducted to replicate the findings from Study 1 and extend them in a number of important ways. This study will focus on 5th grade classrooms feeding into one of ten middle schools. The procedures will be identical to those in Study one. However, follow up data will be collected in the fall and spring of participants' 6th grade year. Using this design, the study will examine whether intervention effects continue across the transition to middle school. This is an important extension, as the middle school transition is a period of increased bullying and decreased psychosocial and academic adjustment. Furthermore, few studies have looked to see whether intervention effects last beyond the school year in which the intervention was conducted.

Analysis
of the Study 1 and Study 2 data will focus on evaluating the effectiveness of the DRT-based in intervention in increasing defending behaviors and whether such increases in defending lead to downstream positive effects, including reduced aggression and peer victimization and increased psychosocial and academic adjustment. Also to be examined is whether the intervention is more effective for some children than others based on a number if intrapersonal and interpersonal factors. The ultimate objective of this project is to determine whether the DRT-based intervention should be incorporated into existing antibullying
curricula being used in schools. Materials teaching school counselors as to how to conduct the intervention will be created and made available for schools wishing these resources. The information gained from this study will also help investigators further improve the intervention through the identification of factors that may reduce program efficacy and, therefore, should be the target of additional intervention efforts.

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

The targeted audience for this year was the scientific community through article in peer-reviewed journals and an invited talk to faculty at the University of Alabama.

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

Major goals of the project:
Driven by empirical research documenting the pernicious effects of peer victimization (i.e., being the target of peers' aggression) on children's mental health, behavioral development, and academic success, as well as media coverage of bullying-related deaths, combating bullying (i.e., repeated aggression toward a weaker peer) has become a national priority. These efforts have increasingly turned to fostering defending behaviors, such as sticking up for and emotionally supporting children who are bullied and informing an adult about the victimization. However, current anti-bullying intevention efforts show
only modest effectiveness. Moreover, the methods used to motivate changes in defending are not derived from theory or empirical evidence of how to best change behaviors. The proposed research will assess a novel intervention activity based on Deviance Regulation Theory (DRT) to increase defending behaviors. Deviance Regulation Theory uses well-founded psychological principles to increase desired behavioral changes. This proposed project will address five goals: 1) determine whether a DRT-based intervention increases defending behavior and whether increases in defending are highest among children who perceive defending to be non-normative, 2) identify individual characteristics (gender, popularity, peer victimization, empathy, moral disengagement, self-efficacy for defending, perceptions of defenders) that moderate the efficacy
of a DRT-based intervention, 3) investigate whether a DRT-based intervention indirectly changes aggressive behavior and peer victimization by increasing the level of defending in a classroom, 4) determine whether a DRT-based intervention increases psychological wellbeing and school adjustment and whether those improvements can be accounted for by decreased aggression and peer victimization, and 5) identify individual characteristics and classroom climate variables predictive of defending victims, reinforcing bullying, aggressing against peers, and being the target of peer victimization, as well as the manifestation of related adjustment outcomes. Study 1 will examine these effects across a single school year. Study 2 will examine the long-term effects of the intevention across the middle school transition. It is anticipated that the DRTbased
intervention will increase defending behaviors leading to reductions in bullying and peer victimization. In turn, children in classrooms in which the DRT-based intervention has been implemented should evidence reductions in psychosocial problems and school maladjustment. It is further anticipated that the DRT-based intervention will be most effective with girls; children high in popularity, peer victimization, self-efficacy for defending, and increased positive perceptions of childreh who defend victims of bullying; and children low in moral disengagement. These findings will provide useful information for additional targets of subsequent intervention work (e.g., how to lower moral disengagement in order to increase receptivity to
intervention efforts). The final product developed from this work will be training materials for school counselors who should be
able to easily implement the DRT-based intervention as part of their ongoing anti-bullying curriculum.

Accomplishments under these goals:
We have continued to analyze data from this project. In addition to the paper already published from these data (Troop-Gordon, Chambless, & Taylor, 2021; Troop-Gordon, Frosch, Totura, Bailey, Jackson, & Dvorak, 2019), a paper has been accepted based on these analyses during the previous reporting period (Crumly, Thompson, McConnell, & Troop-Gordon), and a second paper (Corbitt-Hall & Troop-Gordon) is under revision for invited resubmission. Furthermore, in addition to one

master's thesis completed using these data, two graduate students are currently analyzing the data for their master's theses. We continue to examine the efficacy of the intervention using various statistical techniques as findings regarding improvements in teacher-reported defending are coming into clearer focus.

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 undergraduate students worked on the project for course credit. Students primarily engaged in analysis of the data and recoding of data for specific projects. Four undergraduate students completed papers, two articles total, that are now published or in press. One doctoral student used the data for an upper-level statistics course and is planning on submitting her findings for publication. Two master's students are using the data for their theses.

Results have been disseminated through scientific journal articles. Due to the COVID-19 pandemic, we have suspended direct work with the schools.

The primary goals are to complete an assessment of the efficacy of the DRT-based intervention activity. If analyses continue to support the utility of the intervention, then a training manual on its use will be created and distributed to all of the schools. A
formal report of the findings will also be written up for the participating counties and schools, and we will continue to publish journal articles based on the data.

Book Chapters Awaiting Publication 2022
Troop-Gordon, W., Schwartz, D., Mayeux, L., & McWood, L. M. (in press). Peers and psychopathology. To appear in B. Halpern Feisher (Ed.), The Encyclopedia of Child and Adolescent Health.

Journal Articles Accepted 2022
Leary, A. V., Dvorak, R. D., Troop-Gordon, W., Blanton, H., Peterson, R., Kramer, M. P., De Leaon, A. N., & Magri, T. (in press). Test of a deviance regulation theory intervention among first-year college student drinkers: Differential effects via frequency and quantity norms. Psychology of Addictive Behaviors.

Journal Articles Published 2021
Bukowski, W. M., & Troop-Gordon, W. (2021). Replication studies of critical findings form the peer literature: An introduction. Developmetnal Psychology, 57, 2007-2010. http://dx.doi.org/10.1037/dev0001286

Journal Articles Awaiting Publication 2022
Crumly, B., Thomas, J., McWood, L. M., & Troop-Gordon, W. (in press). Does social withdrawal inhibit defending bullied peers and do perceived injunctive norms mitigate those effects? Developmental Psychology.

Book Chapters Awaiting Publication 2022
Rudolph, K. D., Troop-Gordon, W., & Ye, Z. (in press). Adolescence, physiological adaptation, and the development of stress responses. To appear in E. Skinner & M. Zimmer-Gembeck (Eds.), Handbook on the Development of Coping.

Changes/Problems
The COVID-19 pandemic has continued to slow down progress, as students have had to remain socially distanced, classes had to be restructured to accommodate online learning, and absences have been frequent due to illness.

Closing Out (end date 09/06/2023)

Advancing Military Family Science through Research and Outreach

Project Director
Mallory Lucier-Greer
Organization
Auburn University
Accession Number
1017588

Advancing Military Family Science through Research and Outreach

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

The Alabama Agricultural Experiment Station (AAES) is committed to improving the lives of Alabamians via solution-focused research. This proposal seeks to apply that mission to a population of individuals who are committed to serving Alabama and our nation, military-affiliated citizens. Over 10% of Alabamians have served or currently serve in the United States (U.S.) Armed
Forces (see Table 1), with a high proportion of those recruits, veterans, and reserve component members residing in rural areas
(see Clark, 2015 for an overview; Holder, 2017). When accounting for the parents, spouses, and children of service members, a sizeable portion of the state directly or indirectly "serve and sacrifice" for our country.

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 work of this Hatch project will produce two primary deliverables: the creation of original military family research focused on
issues relevant to Alabama and the development of a digital repository to collect military family research and make it accessible
to policy makers, such as those at the Department of Defense (DoD) and the U.S. Department of Agriculture (USDA), researchers, helping professionals, and families in Alabama, as well as nationwide.
Deliverable 1 - Conducting Military Family Research: Original research will be conducted to advance the field of military family science and examine critical issues within the state, specifically with regard to employment opportunities (1a), youth wellbeing
(1b), and addressing the needs of rural, geographically dispersed military families (1c). We will utilize established datasets to examine each of following research priorities via secondary data analytic procedures (see Research Procedures below).
1a - Employment opportunities: Identify how family circumstances (e.g., geographic location, parental socioeconomic status, family structure, family values) influence decisions to enlist and how the context of military service impacts the socioeconomic
and physical well-being of individuals as they move into young adulthood and pursue families of their own.
1b - Youth well-being: Identify youth in active duty military families who are faring well and those who are not, and examine how family factors (e.g., geographic location, parental socioeconomic status, family structure, parental mental health) play a role
in youth mental health, academic performance, and physical health.
1c - Addressing the needs of rural, geographically dispersed military families: Examine the needs of active duty and activated reserve component service members who are in the midst of a deployment, and understand their access to and utilization of available resources.
Deliverable 2 - Developing a Digital Repository of Military Family Research: A repository of military family research will be developed in collaboration with a team of information technology (IT) specialists and librarians to ensure that this "digital library"
is on the frontier of knowledge acquisition and application. The DoD's Office of Family Readiness has specifically requested the
development of this repository. Holdings will include military family research from varied disciplines, including, but not limited to
family science, psychology, social work, sociology, and public health. The goal is to translate and disseminate research into useful implications and enhance access to research as a means to bridge the gap between research and practice. The repository will be continuously updated and freely available online to diverse stakeholders, including policy makers, researchers,
helping professionals, and families. Allowing research to be accessible to these various stakeholders will promote a communitylevel
approach to providing services to military members and their families, a vision that is in line with the priorities of AAES.

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

This project encompasses a research component and an outreach component, thus the target audiences are diverse. For the research component (Deliverable 1), we are targeting family scientists and policymakers who utilize research in their work to develop protocols, policy, and services for military families. For the outreach component (Deliverable 2), the target

audiences include helping professionals (e.g., therapists, school counselors, and military family life consultants), military leadership, and military families who may benefit from research that is translated into everyday language and practical applications.

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

With regard to Deliverable 1, research is being conducted on three critical issues, specifically: (1a) employment opportunities and circumstances that influence decisions to enlist in the military, (1b) the well-being of youth in military-connected families, and (1c) examining the needs of geographically dispersed military families, especially those in the Reserve component and those in rural areas. Data for each of these projects have been collected and analyses are underway. Findings are expected to increase knowledge on military and community contexts that promote well-being and financial security.
This year, the project focused on Deliverable 1a (circumstances that influence decisions to enlist in the military; see Lucier-Greer publication under review in the "products" section) and 1c (identifying strengths within military families to help them cope with military life stressors; see presentations under "other products" section).
From the knowledge derived from these products:
From the research derived from Deliverable 1, there was:
• An increase in knowledge pertaining to how family circumstances influence decisions to enlist and how the context of military service impacts the socioeconomic and physical well-being of individuals as they move into young adulthood.
• An increase in knowledge regarding the needs of active duty and activated reserve component service members who are in the midst of a deployment, and understand their access to and utilization of available resources.
With regard to Deliverable 2, external funding was secured for another funding cycle (USDA/NIFA 2017-48710-27339 and USDA/NIFA 2021-48710-35671; PI: Dr. Mallory Lucier-Greer) to support the development of a digital repository to collect military family research. With the support of the Hatch project and this additional funding, some notable accomplishments have emerged, including:
• An increase in available resources for military families and those who work on their behalf. Our online library contains 3,668 holdings (e.g., research articles, research summaries, action-based reports) that are free and easily accessible to all of our stakeholders.
• An increase in knowledge of military family research among multiple stakeholders, including military families, helping professionals, and policymakers. This is evidenced by the number of people who follow our work. To date, approximately 400 people have signed up to receive our monthly newsletter that provides research-based applications for military families and those who work on their behalf. We also have over 2,600 followers on social media that regularly interact with our content; our
social media posts provide quick facts related to recent research on military families and provide links for users to find more information on a variety of topics related to well-being of military families.
• An increase in research-informed action as families, professionals, and policymakers utilize research to inform their decision-making. This is evidenced by the number of organizations and agencies who are requesting our resources to inform their policies and procedures, including the Office of Military Family and Community Policy at the Department of Defense as well as the Airmen and Family Readiness leadership.

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.

With regard to professional development, we have engaged in multiple events to train faculty, students, and policymakers on how to use the digital repository and presented at conferences to enhance awareness and use of the digital repository of military family research among helping professionals and military leadership.
Faculty and students also have ongoing access to Auburn University's HR programs to support professional development.

How have the results been disseminated to communities of interest?
With support from this Hatch project and supplemental funding to support the plans of this Hatch project (USDA/NIFA 2017-48710-27339 and USDA/NIFA 2021-48710-35671; PI - Mallory Lucier-Greer), we have established and continue to promote a webpage (www.MilitaryREACH.org) that serves as our primary hub of dissemination; this is where research summaries and report are posted and are publicly available to communities of interest.

What do you plan to do during the next reporting period to accomplish the goals?
Deliverable 1: We will continue to utilize data to examine issues that align with the priorities of AAES and the needs of Alabama. Progress with regard to data analysis is expected. More specifics are provided for each project below.
Deliverable 1a - The Military as a Source of Employment. The publication related to this deliverable is under review. The

Add Health dataset is a large, rich, longitudinal dataset spanning over 13 years. Our team utilized longitudinal data to examine the role family plays in military enlistment and provided evidence of the economic and health impact of military enlistment - a
topic that is often debated but has lacked empirical examination. We will promptly respond to reviewer feedback on this manuscript.
Deliverable 1b - The Well-being of Youth within Military Families. The publication related to this deliverable is under review. Using data from the Military Family Life (N=273 military families), we identified 3 profiles of adolescents in military families based on their mental health profiles. We will promptly respond to reviewer feedback on this manuscript.
Deliverable 1c - Individual and Family Well-being among Activated Reserve Component Service Members. The Army STARRS study consists of five components intended to capture the experiences of service members in different jobs and phases of the military life cycle and deployment cycle. To address this deliverable, we will utilize the All Army Study (AAS) component of Army STARRS. The AAS is a probability global sample of 21,449 active-duty Army soldiers and activated Guardsmen and Reservists between the ages of 18 and 61 in various stages of the deployment cycle. The data were collected between 2011 to early 2013. Information regarding demographics, deployment experiences, interpersonal relationships, and mental health (e.g., psychological resilience, the risk for self-harm, suicidality), among others, were collected. Soldiers also allowed the study administrators to link both their Army and DoD administrative records to their survey
responses. This study will utilize data from the interviews in Kuwait when the service members were transitioning to or from combat zones in Afghanistan. To understand the differential needs of active duty service members and activated reserve component service members, between groups analyses will be conducted (e.g., comparisons on measures such as mental health, coping, and concern for family). If differences exist, a within-group study of activated reserve component service members will be conducted to identify "high risk" and "low risk" service members and to understand their access to and utilization of military and community resources. This work has implications for the training of reserve component service members, particularly those who are in rural areas at greater distances from established military facilities.
Deliverable 2:
We will continue to utilize technological advances in library science to connect diverse audiences with consumable research. We will utilize responsive technologies designed to adapt in response to the layout of the device viewing the library (e.g., different configurations for tablets, laptops, phones).

The database will be indexed by Google and other search engines. This means that the search engines render the content of our library, and take note of key signals (e.g., keywords and phrases). When those search engines are used, results from our database will appear, thus increasing traffic to the library.

Journal Articles Accepted 2021
Sherman, H., Frye-Cox, N., & Lucier-Greer, M. (2021). Combat deployment experiences and Soldier mental health: Examining the factor structure of a combat experiences scale. Military Medicine, usab456. https://doi.org/10.1093/milmed/usab456

Journal Articles Under Review 2021
Lucier-Greer, M., O'Neal, C. W., Reed-Fitzke, K., Peterson, C., & Wickrama, K. A. S. (under review). Post-high school military enlistment and long-term well-being.

Conference Papers and Published 2021
Lucier-Greer, M., Quichocho, D. & Walker O'Neal, C. (2021). App-based continuing education for helping professionals: Research competency findings from an efficacy study of exposing practitioners to military family research [Poster presentation]. National Council on Family Relations, Virtual Conference. (National).

Sherman, H.,Tidwell, A., Lucier-Greer, M., & O'Neal, C. W. (2021). Child difficulties during parental deployment & anxiety: A focus on measurement & family processes [Poster presentation]. American Psychological Association Annual Convention – Division 19, The Society of Military Psychology, Virtual Conference. (National)

Lucier-Greer, M. (2021, February). Identifying mental health profiles of youth in military families [Poster presentation]. 2021 Auburn University Faculty Research Symposium, Virtual Conference.

Other
Lucier-Greer, M., & Abbate, K. (2021). Military REACH: Linking research and practice [Invited presentation]. Airman & Family Readiness Center Basic Course, Maxwell Air Force Base, AL.
Workshop presented at Maxwell Air Force Base - Our team was given the opportunity to teach family service providers about how they can utilize research-based tools and products in their work with military families. The training took place here in Alabama, and the family service providers came from all over the world to receive the training.

Lucier-Greer, M., Walsh, B., Lanas, T., & Jerome, J. (2021, November). Military and Veteran family virtual town hall [Invited panelist]. Central Alabama Veterans Collaborative, Virtual town hall meeting.

Changes/Problems
Meaningful progress has been made with regard to each of the deliverables, but there were certainly roadblocks that were encountered with regard to productivity and output given the COVID-19 pandemic.

Critical Issue

Food Systems and Food Safety

Food Safety Training for Food Service Workers

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002288

Food Safety Training for Food Service Workers

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

The Centers for Disease Control and Prevention (CDC) estimates that approximately 48 million people get sick, 128,000 are hospitalized and about 3,000 die as a result of foodborne illnesses annually. Proper training of food service workers can help to reduce these numbers by emphasizing the importance of food safety principles.

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 122 two-day food protection manager certification classes (ServSafe) for food service workers were offered in Alabama counties. Twenty-Six individuals were proctored for the ServSafe Manager Protection Exam. As a result of these classes and proctoring, about 950 food service workers completed the certified food safety training resulting in a 72 % passage rate.

The two-day food protection manager classes allowed the students to have more time with the material they must know plus they had the opportunity to have information they did not understand explained to them in more detail. The trainings delivered information on food safety principles associated with foodborne illnesses, essential worker hygiene, proper preparation of foods, proper cleaning, and sanitation.

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

Attendance in the training allowed the clientele more time to learn the information so that they could pass the required exam. Passage of the exam gave the client a Food Protection Manager certification that is good for five years. However, even if the client didn't pass the exam, they were given a document showing attendance which by ADPH criteria allows them to continue to operate their business for at least one year. However, during that period, they would need to attempt the training and exam again in hopes of passing.

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

The students would be able to take the information they have learned back to their facilities and incorporate into their practices to produce a safer food for their clientele. Because we work very closely with the local county public health departments, passage or the lack thereof is shared with those health departments. Because these individuals work for permitted food service operations, certifications are often posted in those operations so the public can see that the facilities have certified individuals employed there.

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

Due to the COVID-19 pandemic, face to face trainings had to be administered with COVID-19 protocols in place, such as always wearing a face mask, 6 ft social distancing as well as proper sanitizing of all surfaces. This protocol limited the ability to do trainings as well as individual's ability to attend trainings. Also because of social distancing, class size was limited which meant fewer students could be taught.

Since there are other entities that offer this training, including the National Restaurant Association which determines how the trainings can be administered, it is becoming more difficult to compete for clients as well as to have full classes even when the Food Safety and Quality team can offer them. This could lead to it being a disadvantage to offer classes, especially when only have one or two registering as these are two-day, intense trainings that require extensive travel and set up.

Food Safety Training to Sell Cottage Foods

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002289

Food Safety Training to Sell Cottage Foods

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

The cost of starting a business can be very expensive, but with the passage of the Alabama Cottage Food Law in 2014, producers could produce products in their homes without the usual costly overhead. The regulatory authority for Alabama Cottage Food is the Alabama Department of Public Health (ADPH). As such, part of the criteria to be a registered Cottage Food Producer was to attend and pass an approved food safety certification.

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.

Part of the criteria to be a registered Cottage Food Producer was to attend and pass an approved food safety certification. Approved certifications available at the time of passage, included only ANSI approved certifications that were restaurant based. These certifications were expensive, time consuming and required the passage of a 90-question multiple-choice exam, and most of the information did not pertain to the Cottage Food Producer. The Alabama Cottage Food Law training, developed by the Food Safety and Quality team, is geared specifically to the home producer at lesser expense while still providing information pertinent to their business. This training gives the cottage food producer valuable information to safely prepare food in their home.

Successful passage of the exam by the clientele demonstrated that they had the necessary knowledge on the law, food safety recommendations and basic water bath canning.

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

Clientele received an approved food safety certification for cottage food that is good for five years. As a result of this certification, clientele can make up to $20,000.00 gross annually in sales. With passage of the exam, the client has a better understanding of the Cottage Food laws as well as applicable safe food handling practices.

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

Consumers and purchasers of products produced by clients who have taken and successfully passed the Alabama Extension certification can have some assurance that the food items were prepared in a safer environment.

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

Because this certification is required by the Alabama Department of Public Health, clientele must register with their local county health department. Clientele must also show proof of certification to obtain business licenses. Many venues at which the clientele might want to participate require verification of their certification. Therefore, with all the many instances wherein the clientele participates, they will have to share this certification, and that can include the public.

The Alabama Department of Public Health is the regulatory agency for the Alabama Cottage Food Law. With the onset of the COVID-19 pandemic, we were granted permission to transition the Alabama Extension training (videos to teach, registration and testing) online. However, the Alabama Cottage Food Law was revised in May of 2021. This revision resulted in a change in the law and therefore the AL Extension training was no longer applicable. Again, with permission from ADPH, we were allowed to continue use of our training until December of 2021. Now the Food Safety and Quality team with AL Extension must update and vet the training through ADPH to be able to continue to offer this needed certification for Alabama citizens.

With the changes to the Alabama Cottage Food Law, the Food Safety and Quality team will have to update the training, as well as the exam, so that it can comply with the current law. The team will have to do in-depth study of certain processing techniques to be able to offer guidance on the law as well as develop new questions to access the level of understanding of the client in reference to the new law criteria and new product allowances.

National Poultry Technology Center (NPTC): Meeting the need of the commercial poultry industry

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002286

National Poultry Technology Center (NPTC): Meeting the need of the commercial poultry industry

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

The commercial poultry industry in Alabama is estimated at $15.1 billion in revenue to the state's economy. There are 24 integrated complexes growing broilers (meat birds) in Alabama. These integrators employ service technicians to work with producers. There are 2,475 producers managing roughly 10,000 commercial broiler houses in Alabama. Training is needed on poultry housing and technology for poultry farmers, integrator technical services (service technicians, building coordinators, corp. veterinarians, managers) equipment manufacturers, builders, agricultural lenders, commodity associations, federal agencies, and other industry partners. Programs will increase the ability of participants to manage (or assist) in commercial broiler and breeder operations.

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 2,191 people were reached through 30+ educational events in 2021. Of the instate participants that reported demographics, 16% were female and 83% were male. Out of state participants were 22% female and 72% male. We were able to maintain the number of workshops we hosted through virtual webinars, but the consensus is that our stakeholders would rather participate in person. We then moved from virtual to teaching on commercial farms while the University was restricting visitors. Participation and feedback were excellent from the participating service technicians. Faculty leading the Masters of Avian Medicine (MAM) program at the University of Georgia reached out in 2021 to get NPTC to host two two-day hands-on training workshops for the veterinarians in their program. The feedback was excellent from both the faculty and the MAM students with the intent to continue the collaboration in summer 2022. The creation of the NPTC REEU program for undergraduates allowed NPTC faculty to collect vital on-farm research information to address issues concerning an industry push towards the use of big data. Student projects focused on on-farm data quality. The students increased our ability to generate more quality extension articles. A total of eight peer reviewed publications were published, five in the new NPTC Tools of the Trade Series. This new series provides a succinct set of steps to properly use a meter or method to collect data on

the farm. Initial feedback from growers and integrators have been positive. They specifically mentioned that they like the worksheets that guide the reader as well as collecting and maintaining data for their records. The poultry housing tips calendar has been a continued success in that calendar sales (3,675 this year; 9,289 total) and feedback continue to be positive. The smartphone app has grown to 8,357 total downloads. The biggest value growers and service techs mention is the ability to use the min-vent calculator in the commercial houses without the need for broadband (which continues to be an issue on most farms). The social media platforms have been successful in conveying to industry professionals what the Center is doing throughout the year and allows us to quickly distribute our latest articles to interested stakeholders. Even though Covid has continued to hamper the travel by many of our stakeholders, NPTC faculty and staff have worked to develop creative work arounds and actively participate with our stakeholders.

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

The economic impact for National Poultry Technology Center extension work for 2021 is estimated at $44,269,529.07. This impact is based on feed conversion efficiency improvement estimates obtain as a result of our education and training programs. We hosted over 1,028 industry representatives for virtual zoom meetings for an estimated $22,207,964.72. We conducted classroom style training for over 181 industry representatives for an estimated $6,516,928.69. Approximately 326 people received in-person on-farm demonstration and training that results in an estimated $15,258,974.46 saved. We also hosted two separate electrical system hands-on demonstrations on farms for two complexes for an estimated $285,661.20 of savings by preventing on-farm power and backup system failures.

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

By helping to keep poultry producers profitable, more chicken meat and by-products are available at an affordable price for U.S. consumers.

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 NPTC has a LinkedIn page (1,517 followers) and Facebook page (568 followers) where our educational products are featured as they are officially released. We maintain close relationships with Alabama Poultry and Egg, Tennessee Poultry and Egg, and the Poultry Times magazine editors so our publications are spread throughout the industry. We also provide information through the Poultry Division of the Alabama Farmer's Federation. We also report our research and extension efforts as a quick summary at all our invited presentations throughout the southeastern poultry producing states.

We increased efforts that were offered virtually. We plan to upgrade the way we distribute and collect evaluation information during our training seminars. We are working to improve our assessment methods of determining program impact. We are working to update our poultryhouse.com website.

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

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

Creating and sustaining a productive residential or community gardens can be hindered by factors such as lack of technical knowledge, lack of resources, and a lack of volunteer involvement and other local support. Food insecurity remains a problem in many communities.

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

- Residential food gardens remain important. However, the passion to start or restart a garden might need support to learn how to be successful. From program participant surveys, we know that 63% of our clients implemented something we taught.
- People continued to donate produce to local food charities and neighbors - 32,580 total pounds in 2021, or 16+ tons.
- Extension MG Volunteers grew and donated 2,046 transplants, donated 86% of the total GMGM produce donations, and served as local ambassadors for our program.
- Program participants reported an average program value of $62/program.
- Program participants reported an average cost savings from implementing techniques we taught, $50/program.
- GMGM donations contributed fresh produce to 6,516 Alabama families.
- Based on an average fresh produce retail value of $1.85, the 2021 GMGM donations totaled $60, 274.
- Due to HG team investments, we continued many partnerships that contributed to GMGM program success - Extension Master Gardener Volunteers, Extension Food Safety and SNAP-Ed Agents, 4-H, and County Extension Coordinators.
- The overall community ROI for this program was 44:1 in 2021.

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

- Communities embraced the program. Produce donations were recorded by individuals and food donation sites using our online survey.
- Recipients had fresh produce they otherwise might not have had, and saved money on their food bills.
- Extension MG Volunteers grew and donated produce and transplants. They also mentored people to learn how to manage a food garden at home or as a community effort, and maintained domonstration gardens.
- Program participants implemented what we taught - from programs and one?one answers delivered by Extension Home Grounds Agents and Volunteers.
- Testimonials:
-- "Great information on garden pests + products that are appropriate."
-- "Invaluable, other places never answer."
-- " My husband has called almost every gardening season regarding some gardening matter or other. It is nice to know there are experts around, as one season is never like the previous one(s)."

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

Extension MG Volunteers hosted information booths at numerous outlets. They also gave out seed packets with growing instructions - to the general public via these booths and at community food donation sites. GMGM donations contributed fresh produce to 6,516 Alabama families.

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

Outcomes have been disseminated to communities of interest through social media and local media - in print (newspapers, magazines), radio and television.

A new grant from Alabama R,C&D will support our demonstration gardens and provide funding for materials to help new gardeners grow food at home.

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.

Continued population growth, as well as increased standards of living, is driving an expanding demand for high quality seafood
products. Consequently, the commercial production of aquatic species is currently the fastest growing component of agriculture.
Unlike terrestrial agriculture, which is based on a limited number of animal species, aquaculture relies on the culture of over 300
different species of fish and shrimp. This large number of species allows for diversity in the industry however, it also makes it more difficult to optimize culture conditions and feed formulations.

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 feed represents the primary cost in rearing animals, the development of cost effective feeds is critical for long-term success of the industry. In order to continue to reduce production costs, minimize environmental impacts, and reduce our dependence on expensive and limited marine nutrient sources as feed ingredients, considerable research must be conducted. This research approach needs to identify nutrient requirements,
determine digestibility values for various ingredients, examine palatability of ingredients, determine the effects of anti-nutrients,
and evaluate the influence of processing conditions on feed quality and nutrient availability.

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

The primary groups interested in this work are 1) current and future shrimp and fish farmers in the US 2) commercial nutritionists working with shrimp and fish feeds 3) researchers developing growth models for shrimp and fish. The final end users of the information are all consumers who utilize cultured seafood products.

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

Major Goals
1) To collect and validate nutrient requirement data.
2) Improve practical feed formulations.
3) Determine best management practices for feeding various life stages.
4) Train the next generation of industry representatives.
5) Distribute information to the industry through publications and presentations.

Objective
1. Determine dietary requirements and the effects of anti-nutrients in fish (catfish, tilapia, Florida pompano, red snapper, white sea bass and yellow tail) and shrimp (Pacific white).
1. Identify limiting AA, determine and confirm requirements and evaluate AA balance in practical feed formulations.
2. Evaluate the use of new genetic lines of oil seed meals with reduced level of anti-nutrients.

2. Develop and improve practical diet formulations for fish and shrimp.
1. Identify limiting nutrients in practical plant-based diets.
2. Evaluate the efficacy of enzyme supplements and the effects of the ingredient matrix on performance of fish and shrimp.
3. Determine digestibility coefficients for a range of ingredients in fish and shrimp.

3. Determine the influence of diet formulations on nutrient loading of culture systems.
1. Evaluate nutrient loading of P and C in production systems for catfish and shrimp.

4. Evaluate interactions of the environment, stocking density and presence of natural foods on nutritional requirements and production performance of shrimp.

5. Evaluate the interactions of diet and water supplements on the performance of shrimp in intensive mixotrophic production systems.

What was accomplished under these goals?
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, red drum, red 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 four plant-based shrimp feeds containing various attractants on the performance of Pacific white shrimp reared under pond production conditions and 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 and Florida pompano. 4.The evaluation of plant-based diets in bioflock
production systems for shrimp. 5. The quantification of the lysine requirement for Florida pompano. Work with freshwater species included: A. Use of corn poultry by product meal as a feed ingredient for catfish. B. The evaluation of essential amino acid requirements in channel catfish. C. Evaluation of new ethanol by products as feed ingredients for fish and shrimp.

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.

As committee chair/co-chair Dr. Davis graduated three PhD and three M.S. students and I served on the committee of one M.S. student and one PhD student who graduated. My program supported two research associates, 13 graduate students who are still working on their programs. I hosted four visiting scientists and one visiting PhD student. All receiving training in aquaculture, aquatic animal nutrition and laboratory management.

My research group maintains direct interaction with farmers and feed mills. This research group authored 11 journal publications, 2 popular articles and we have 5 publications in early view. Within my group we made 10 presentations at national and international meeting's and I participated in 28 industry based meetings.

Presently, the program supports a rather large group of students, visiting scientist, technicians, research associates and extension professionals. To support these and expanded activities we actively seek state, federal and private funds to maintain the program. Research and demonstration project will continue to be developed and completed. Publication of research is ongoing, and we have numerous publications in the work or submitted so we are well positioned for the next year. Major challenges for the year include the recovery from hurricane damages on the coast, renovating office space and maintaining an ageing research facility. Research will continue with catfish, tilapia, Florida pompano and marine shrimp our primary target species. Additionally, we will work with marine fish that may become available from other laboratories.

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Galkanda-Arachchige, H., A. S. Hussain, and D. A. Davis. "Fermented corn protein concentrate to replace fishmeal in practical diets for Pacific white shrimp Litopenaeus vannamei" Aquaculture Nutrition, 27, 1640– 1649

Galkanda-Arachchige, H., R. P. Davis, S. Nazeer, L. Ibarra-Castro, D. A. Davis. 2021. Effect of salinity on growth, survival, and serum osmolality of Red Snapper, Lutjanus campechanus. Fish physiology and biochemistry.

Galkanda-Arachchige, H., H. Stein and J. Guo, and D. A. Davis. 2021. Soybean meal sourced from Argentina, Brazil, China, India and USA as an ingredient in practical diets for Pacific white shrimp Litopenaeus vannamei. Aquaculture Nutrition. 27(4): 1103-1113.

Vo, L. G., H.G. Arachchige, D. Lassonova, D. A. Davis. 2021 Efficacy of modified canola oil to replace fish oil in practical diets of Pacific white shrimp Litopenaeus vannamei. Aquaculture Research.52(6):2446-1459

Journal Articles Published 2021
Galkanda-Arachchige, H., H. Stein and J. Guo, and D. A. Davis. 2021. Soybean meal sourced from Argentina, Brazil, China, India and USA as an ingredient in practical diets for Pacific white shrimp Litopenaeus vannamei. Aquaculture Nutrition. 27(4): 1103-1113

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Davis, R. P., G. Salze, E. Fanning, C. Silbernagel, D. Rotstein, D. A. Davis, and M. A. Drawbridge. 2021. A comparison of growth and taurine retention between plant and animal protein-based diets in juvenile white seabass Atractoscion nobilis Aquaculture. 533:736082

Guo, J., C., Starkey, D. A. Davis. 2021. Efficacy of various coated materials to prevent nutrient leaching for Pacific white shrimp Litopenaeus vannamei commercial diets. Journal of the World Aquaculture Society. 52(1), 195-203.

Arachchige, H.G. L. Roy and D. A. Davis. 2021 The effects of magnesium concentration in low salinity water on growth of Pacific white shrimp (Litopenaeus vannamei) cultured in low salinity water. Aquaculture Research. 52(2): 589-597.

Other Published 2021
Reis, J., A. Weldon, S. Walsh, W. Stites, M. Rhodes, D. A. Davis. 2021.Response of Pacific white shrimp to various diets when provided feed on demand using a passive acoustic feeders. . Global Aquaculture Alliance. March 15, 2021.

Other Published 2021
Galkanda-Arachchige, H, L. A. Roy, A. M. Kelly and D. A. Davis. 2021. Low-cost salt mixture can replace expensive, reconstituted sea salts in inland low salinity shrimp farming Global Aquaculture Alliance

Conference Papers and Published 2021
Soybean meal sources and shrimp feeds". D. Allen Davis and H. S. C. Galkanda-Arachchige. AquaExpo 2021 Guayaquil, Ecuador. October 25-28.

"Magnesium or magnesium to calcium ratio? Effects of different levels in low salinity water on growth and survival of pacific white shrimp (Litopenaeus vannamei)." Harsha Galkanda-Arachchige, Luke A. Roy, and D. Allen Davis. Oral presentation at the World Aquaculture Society (WAS) meeting, San Antonio, Texas, USA. August 11-14, 2021.

"Use of metabolically modified canola oil as a replacement for fish oil in practical diets of pacific white shrimp Litopeneaus vannamei." Alexis Weldon, D.A. Davis, M. Rhodes, J. Reis, W. Stites, and S. Walsh. Oral presentation at the World Aquaculture Society (WAS) meeting, San Antonio, Texas, USA. August 11-14, 2021.

"Feed management of Litopeneaus vannamei in a high density biofloc system". Alexis Weldon, D. Allen Davis, Melanie Rhodes, Joao Reis, Cody Stites, Paulo Ito. Oral presentation at the World Aquaculture Society (WAS) meeting, San Antonio, Texas, USA. August 11-14, 2021.

"Quantitative lysine requirement for juvenile Florida pompano Trachinotus carolinus fed plant-based diets." William Stites, Alexis Weldon, Joao Reis, Samuel Walsh, Robert Davis, Melanie Rhodes, D. Allen Davis. Oral presentation at the World Aquaculture Society (WAS) meeting, San Antonio, Texas, USA. August 11-14, 2021.

"A comparison of growth and taurine retention between plant and animal protein-based diets in juvenile white seabass Atractoscion nobilis." Robert P. Davis, D. Allen Davis, Guillaume Salze, Erica Fanning, Constance Silbernagel, David Rotstein and Mark A. Drawbridge. Oral presentation at the World Aquaculture Society (WAS) meeting, San Antonio, Texas, USA. August 11-14, 2021.

Effects of fermented corn protein concentrate to replace fishmeal in practical diets for Pacific white shrimp Litopenaeus vannamei". Harsha Galkanda-Arachchige, Aya S. Hussain, Allen Davis (2021). Oral presentation at the World Aquaculture Society (WAS) meeting, San Antonio, Texas, USA. August 11-14, 2021.

Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002400

Urban Agriculture Food Production Systems

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

In this modern era it is hard to imagine that food deserts exist within our populated Urban/Metropolitan areas. 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 US households) live more than one mile away from a supermarket and do not own a car. The Urban Ag Food Production Systems Program is designed to engage, increase awareness, and educate clientele about affordable and healthy urban ag production practices.

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

Urban Home Grounds FY2021 reached 97,354 individuals through 390 scheduled activities, virtual programs, and social media engagement. Urban Home Grounds, through social media engagement, reached 61,503 and engaged 7,798 individuals. Direct contact engagements was totaled at 28,053 individuals. Urban Ag Food Systems accounted for 42% (n=11,745) of total Urban Home Grounds programming. Urban Agriculture Food Production Systems participants were 78% (n=9,194) adults, 0.8% (n=91) youth, 32% (n=3,706) black, 44% (n=5,192) white, 23% (n=6,076) male, and 56% (n=6,594) female.

The addition of three new Urban Agriculture Urban Regional Extension Agents has greatly facilitated a broader engagement region and audience. The new extension agents were assigned to urban populated areas which previously were not engaged in Urban Agriculture activities and programming. Their Urban Agriculture programming activities were 176 for FY2021. This is an increase from the FY2020 total of 98 activities.

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

The percentage of adult participants who improved their knowledge of program concepts were as follows: Irrigation practices (70%), Raised Bed and Container Garden Practices (85%), Composting (72%), Rainwater Harvesting and Uses (81%). The average knowledge of urban gardens and raised bed garden use was relatively low (2-3) compared to after the Urban Agriculture programs and demonstrations, higher (4-5). Adult participants indicated that 85% agreed that the program encouraged them to install a raised bed or container garden and adopt composting practices. Resulting impacts: Urban Ag overall: 82% increase in using urban ag best management practices.

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

Use of social media and online programming has allowed the Urban Home Grounds programming team to reach 61,503 and engage 7,798 new audiences across the state of Alabama and the United States.

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

The limitation of broadband internet access has been a challenge for clientele participation of live virtual programming events. T

On?demand video libraries of recorded program sessions have allowed our programming to engage an audience that is usually engaged with family or work activities.

#Earth2TU - Earth Smart Food Systems Education Program

Project Director
Raymon Shange
Organization
Tuskegee University
Accession Number
7002765

#Earth2TU - Earth Smart Food Systems Education Program

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

Interest in sustainably produced food is increasing and encouraging growth in the numbers of local and regional producers of such foods will help revitalize rural and urban economies. Indeed, many consumers now seek products that are produced in a sustainable manner, and they believe such products are safer and of better quality. These consumers have also showed more care of the complete food system and how their food is tied to social, health, environmental and economic factors. The #Earth2TU program assesses production practices, consumer perceptions, as well as educates key stakeholders including producers, students, consumers and others in order to bring about awareness and change in food systems.

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

The #Earth2TU held it's second virtual conference/symposium with EarthWeek 2021, which was a series of 5 symposia dealing with the regenerative agriculture and its relationship with minority communities. Over 200 participants joined the discussions from all over the country. The virtual platform continued for another 6 sessions and adding another 120 participants. Topics included the a History of the 1890s and Participation in Food Movements, Regenerative Fashion, Markets for Regenerative products, Indigenous Medicine, and Justice for Black and Indigenous Agriculturalists. Digital and social media were additional communication outputs from the program.

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

Over 90% of participants reported a gain in (in each of the areas presented) knowledge with respect to environmental and food justice, 1890s participation in food system and community development, markets for regenerative agriculturalists, and the regenerative fashion industry for African Americans. One hundred percent (100%) of participants said that they will utilize knowledge and skills gained and change their behavior to improve operations and interactions in their local food system.

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

The program has reached over 10 states as well as two additional countries to address issues in food systems.

Enhancing Poultry Production Systems through Emerging Technologies and Husbandry Practices

Project Director
Wilmer Pacheco
Organization
Auburn University
Accession Number
1023284

Enhancing Poultry Production Systems through Emerging Technologies and Husbandry Practices

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.

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.

Due to an increasing global population, there is a need for sustainably, efficiently, and safely produced and processed protein, such as poultry. Adapting Precision Livestock Farming (PLF) techniques to poultry production and processing systems will further enhance the industry's capability to meet the growing demand. Consumer and retail demands of the poultry industry have resulted in an expansion in a variety of production and feeding systems with differing constraints and knowledge base. The collaborative research efforts outlined here will further expand the concept of PLF, using automated continuous monitoring
of animals to allow producers to record and assess in real-time, the health and welfare status of their animals. The approach includes the use of automation and robotics, equipment efficiency, facility design, energy, and resource allocation. In addition,
improvements in antimicrobial intervention technologies and processing methods will mitigate the risk of foodborne pathogens in
poultry and poultry products.
Poultry production systems must be optimized to be more energy/resource efficient, minimize their carbon footprint and sustainable through infrastructure development throughout the blockchain of production, that is, breeder, hatchery, producer,
processor, and consumer. Collaborative research can help tie together the different components of the system and their relationships. The consequences of not renewing the project will result in the loss of the poultry industry's position in the global
marketplace and the ability to provide safe and nutritious poultry products to consumers throughout the world.

This multi-state poultry research team is comprised of environmental physiologists, behaviorists, animal welfare scientists, nutritionists, engineers, extension scientists, microbiologists, and economists. These collaborators have access to commercialtype,
pilot scale, and laboratory-scale facilities with the equipment and expertise necessary to work in the proposed areas of research. Collaboration has been documented in the past with successful outcomes reported. Additionally, this multi-state group
has several leading industry experts that are active participants. These industry connections provide valuable input and link researchers with commercial operations/birds/equipment to maximize the relevance and feasibility of research efforts.

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

Target audience includes:poultry farmers, poultry company representatives, researchers, government regulators and consumers.

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

The AL team consisting of Drs. Bourassa, Macklin, and Pacheco work in the broad areas of microbiology (Bourassa and Macklin) as feed milling and nutrition (Pacheco). The work performed by this group has had a significant impact on understanding the source of and spread of two important foodborne pathogens - Campylobacter and Salmonella. They have also investigated the possibility that insects carry more pathogens than previously realized. In addition, this group has looked at ways that feed can be manufactured to maximize nutrient ability as well as to reduce energy costs.

Activities and Projects

1. Evaluation of Salmonella transmission in poultry house dust.
2. Use of acidified peracetic acid or stabilized hydrogen peroxide for Campylobacter reduction on poultry meat
3. Pathogen loads in poultry processing wastewater
4. Pathogens in poultry feed
5. Salmonella and Campylobacter persistence in the poultry house
6. Insects as possible disease vectors
7. Salmonella colonization in the broiler chicken
8. In a field study, we evaluated the effect of conditioning temperature, retention time during conditioning, production rate during pelleting, on pellet quality, and moisture content in finished feed.

Significant Findings and Impacts

1. Salmonella is present in poultry house dust when birds are positive. However, transmission of Salmonella from litter to dust occurs at very low levels. This transmission can be mitigated through good litter management and dust reduction techniques.
2. Treatment of poultry carcasses post-defeathering with acidified peracetic acid did not influence the presence of Salmonella on poultry parts post-deboning. Therefore, acidified peracetic acid antimicrobial treatment at this stage of poultry processing does not provide an adequate benefit to justify the cost of application. Stabilized hydrogen peroxide reduced the levels of Campylobacter on chicken wings by 2 log CFU/mL. This antimicrobial has potential for further investigation as an alternative to peracetic acid.
3. Both Salmonella and Campylobacter can be detected in poultry processing wastewater before, during, and following treatment. These findings will be used to inform novel wastewater treatment train studies intended to allow for the reuse of poultry wastewater for agricultural production processes.
4. No known pathogens were found in animal (poultry) feed; however, Clostridium argentinense was found in several corn samples. What makes this finding interesting is that this bacterium is associated with producing botulism toxin. It is believed that these bacteria aren't a concern to animal health, but more research is being performed to verify this.
5. Salmonella persists in the poultry house for several flocks; however, over time the serovars tend to shift. Favoring those that are more able to survive the time between flocks in the house. Campylobacter though easily found when birds are present rapidly becomes undetectable five days after the flock's removal; however after birds are brought back this foodborne pathogen reappears in all sampled birds.
6. Insects, namely litter beetles, had been shown to carry the parasitic eggs from Heterakis and Histomonas. This knowledge is useful in trying to prevent infection with these parasites in broilers by having a good insect control program in place to reduce the beetle numbers.
7. Several studies were conducted to examine the effects of site of colonization and where the bacteria eventually colonize with two serovars of Salmonella. The results show that regardless of route, birds are easily colonized. Certain routes yielded higher colonization rates those being if this bacterium is inhaled, ingested, placed in the eye or near the cloaca. The site of colonization was high in all the tissue types sampled with the highest incidence being in the ceca and bursa. These results show that Salmonella once introduced into the bird can colonize throughout the animal, making control of these bacteria on the farm that more crucial.
8. The results of this project helped a large poultry integrator to change conditioning and pelleting parameters to improve pellet quality and reduce moisture in the finished feed, which can have an impact on feed conversion ratio.

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

The AL team had trained five graduate students and are in the processes of mentoring eight additional students. All the members of the AL team have mentored several undergraduates. The team has also worked closely with in-state as well as out-of-state and international poultry companies, farmers, and small flock farmers in developing and delivering workshops and
papers that will improve their understanding of poultry housing, management, health, and food safety.

Results have been shared at scientific meetings both orally and through written reports (abstracts, peer-reviewed papers). The more practical findings have been disseminated to target groups through presentations at the appropriate meetings and written material in trade journals.

The AL team members plan on continuing their efforts in this project. With more emphasis by Bourassa and Macklin on Campylobacter and Salmonella control.

Journal Articles Published 2021

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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.

Pacheco, W. J., D. B. Patiño, J. I. Vargas, J. P. Gulizia, K. S. Macklin, and T. J. Biggs. 2021. Effect of partial replacement of inorganic zinc and manganese with zinc methionine and manganese methionine on live performance and breast myopathies of broilers. J. Appl. Poult. Res.https://doi.org/10.1016/j.japr.2021.100204

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

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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.

Munoz, L., W. Pacheco, R. Hauck and K. Macklin. 2021. Evaluation of commercially manufactured animal feeds to determine presence of Salmonella, Escherichia coli and Clostridium perfringens. Journal of Applied Poultry Research. 30 (2). https://doi.org/10.1016/j.japr.2021.100142

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Pal, Amrit. Airborne transmission of Salmonella and its association with dust in poultry houses. Auburn University, MS Thesis, 2021.

Chasteen, Kaicie. AN EXAMINATION OF THE MICROBIOME OF BROILER CHICKENS IN VARYING STATES OF STRESS AND DISEASE MORBIDITY. Auburn University, MS Thesis, 2021.

Talorico, Aidan. Evaluating Litter Sampling Methodology and the Persistence of Nontyphoidal Salmonella in Broiler Flocks. Auburn University, MS Thesis, 2021.

Conference Papers and Published 2021

Pal, A., A. Jackson, A. Urrutia Giron, M. Bailey, A.A. Talorico, J.T. Krehling, K.S. Macklin, and D.V. Bourassa. Shift in microbial composition of dust during growout of broiler chickens. International Poultry Scientific Forum, January 25, 2021. Virtual.

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Talorico, A., J. Krehling, K. Chasteen, L. Munoz, M. Bailey, D. Bourassa, and K. Macklin. 2021. Examining the use of sodium formate salts to reduce Salmonella Enteritidis persistence in broiler litter. Virtual International Poultry Scientific Forum, January 2021

Chasteen, K., K. Macklin, J. Krehling and M. Bailey. 2021. Effects of Gypsum Mineral Treatment on Darkling Beetle (Alphitobius diaperinus) Populations in Poultry Litter. International Poultry Scientific Forum, January 2021

Munoz, L., M.A. Bailey and K.S. Macklin. 2021. Effects of common litter treatments on Campylobacter jejuni prevalence in broilers. Poultry Science 110th Annual Meeting, Virtual, July 2021.

Bailey, M. A., D.V. Bourassa, J.T. Krehling, L. Munoz, A. Talorico and K.S. Macklin. 2021. Effects of common litter treatments on Campylobacter jejuni cross-contamination in broilers. International Association of Food Protection Annual Meeting, July 2021.

Pal, A., M.A. Bailey, K.S. Macklin, and D.V. Bourassa. Effect of poultry litter moisture content on litter to dust transfer of Salmonella. International Association of Food Protection, July 17-21, 2021. Phoenix, AZ.

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Stafford, E. K., G. Harder, K. M. Downs, J. P. Gulizia, S. J. Sasia, and W. J. Pacheco. 2021. Effects of varying corn particle size on broiler performance and organ development from 1 to 21 days of age. Poult. Sci. E-Suppl. 1:210.

Gulizia, J. P., S. J. Sasia, S. M. Bonilla, J. I. Vargas, L. C. Smith, J. L. Sandoval, C. W. Starkey, and W. J. Pacheco. Evaluation of different particle size analysis methodologies for finely to coarsely ground corn. Poult. Sci. E-Suppl. 1:409P.

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Sasia, S. J., J. P. Gulizia, S. M. Bonilla, J. I. Vargas, and W. J. Pacheco. 2021. Conditioning temperature directly affects pellet quality. Poult. Sci. E-Suppl. 1:416P.

Smith, L. C., S. M. Bonilla, J. P. Gulizia, M. Rueda Lastres, F. K. Ovi, J. Escobar, J. Froetschner, and W. J. Pacheco. 2021. Effect of production rate on pellet durability index. Poult. Sci. E-Suppl. 1:417P.

Adkins, J. B., K. M. Downs, J. P. Gulizia, M. S. Rueda, W. J. Pacheco. 2021. Effect of phytase level and form on broiler performance from 1to 21 days of age. M34. International Poultry Scientific Forum.

Audio or Video

McCrea, B., D. Bourassa and K.S. Macklin. 2021. Backyard Chicken Basics: What's bugging your flock. Alabama Cooperative Extension System. YouTube Video, Jan 27, 2021

McCrea, B., D. Bourassa and K.S. Macklin. 2021. Backyard Chicken Basics: Keeping predators out. Alabama Cooperative Extension System. YouTube Video, Jan 27, 2021

McCrea, B., D. Bourassa and K.S. Macklin. 2021. Backyard Chicken Basics: Footbaths made easy. Alabama Cooperative Extension System. YouTube Video, Jan 27, 2021

Changes/Problems

COVID 19 impacted the delivery of our programs; however, we adapted and had gotten most of our findings out.

Epidemiology and Disease Management for Aquatic Species Cultured in west Alabama

Project Director

Anita Kelly

Organization

Auburn University

Accession Number

1022364

Epidemiology and Disease Management for Aquatic Species Cultured in west Alabama

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

West Alabama is home to one of the most unique aquaculture industries in the United States. While aquaculture producers in most other states use levee ponds, most of the production in west Alabama occurs in watershed ponds. These ponds present disadvantages (both real and perceived) that are not prevalent in other aquaculture systems. These ponds are unique in that they are filled primarily through runoff, many of the artesian wells have water with salinity ranges from 2‰ to 10‰, and the ponds generally lack a drain structure making it difficult to drain ponds.

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 low salinity groundwater has enabled west Alabama producers to raise the Pacific white shrimp Litopenaeus vannamei, which can survive in low salinity water. In addition to the Pacific white shrimp, blue crab, hybrid striped bass, Gulf killifish, southern flounder, and Florida pompano have also been successful raised in low salinity waters in west Alabama. The low salinity groundwater availability in west Alabama will enable
expansion of the aquaculture industry if producers choose to use this resource. Channel catfish, Ictalurus punctatus, and hybrid catfish, I. puntatus ? x I. furcatus ?, are the primary aquaculture species in Alabama (105 million pounds of catfish produced on 74 farms in 17,450 water acres). One third of the US catfish production comes from Alabama and is only surpassed by catfish production in Mississippi. It is primarily located within the Alabama Black Belt region counties of Hale, Dallas, Perry, Marengo, Sumter, Greene and Pickens. Most producers in west Alabama produce channel catfish; with only 1,530 acres of hybrid catfish production (USDA NASS 2018). The catfish industry is a major economic driver employing over 2,600 people with a total sales output of $465 million dollars.

The Alabama inland shrimp industry is also concentrated in the Black Belt region. The Pacific white shrimp has been grown in low salinity well water since 1999. Current annual production is approximately 250,000 lb. of shrimp with a farm gate value of over $1 million . Although west Alabama has low salinity artesian groundwater, it must be supplemented with potassium
and magnesium. These deficiencies and high sodium: potassium ratios, have been demonstrated to reduce survival and osmoregulatory capacity of marine species cultured in low salinity water. West Alabama shrimp farmers typically supplement potassium and magnesium with fertilizers rich in potassium i.e., muriate of potash and K-Mag.

Although catfish is the major aquaculture species in Alabama, other commercial farms exist that raise sportfish for stocking recreational ponds and crawfish. All these industries have issues that reduce the sustainability and profitability of the industry. Producers in west Alabama have indicated disease and decreasing yields as major issues. To increase yields, producers are looking to intensify production by using alternative production systems such as intensively aerated ponds, split ponds, and partitioned aquaculture systems, all of which require modification to production ponds. To increase profitability, producers are interested in diversification and raising additional alternative species on their farms, such as marine species that
can tolerate low salinity culture water. Raising freshwater aquatic species in new intensive systems or production of marine species in low salinity waters will inevitably increase the incidence of disease.

Despite the long history of catfish and shrimp culture in west Alabama, producers still lose a considerable amount of their crop to diseases. For catfish, bacterial diseases can result in 40-50% in crop losses annually. The most common bacterial infections in catfish include enteric septicemia of catfish (ESC) (caused by Edwardseilla ictaluri), columnaris (caused by Flavobacterium columnare), and motile Aeromonas septicemia (MAS) (caused by Aeromonas hydrophila and related motile aeromonads). In recent years, the emergence and isolation of A. hydrophila strains that are highly virulent to catfish and new pathogens such as E. piscicida have caused drastic economic losses to catfish farmers. Bacterial infections in catfish are treated using approved antibiotics prescribed through a Veterinary Feed Directive. Currently, only three antimicrobials are

approved by the Food and Drug Administration (FDA) for use in fish cultured for human consumption in the U.S.- oxytetracycline
hydrochloride (Terramycin® 200), sulfadimethoxine and ormetoprim (Romet®), and florfenicol (Aquaflor®). These broadspectrum
antimicrobials can control multiple bacterial infections in fish. These antibiotics are incorporated into feed and fed to fish for a prescribed amount of time. Their treatment efficacy has been proven at a wide range of water temperatures, and they
have been used interchangeably for many fish diseases. For example, both Aquaflor® and Romet® can be used for treating the enteric septicemia of catfish. Terramycin® and Romet® have both been used for treating Aeromonas infections. Antibiotics used in aquaculture are perceived by producers to be expensive and consequently several food fish producers in Alabama do not use antibiotic feed but rather cease feeding fish for a few days to stop the disease outbreak.

The inland shrimp producers have recently reported that survival rates have dropped from 60-70% to 28-40%. Most of the mortality occurs during the acclimation phase of post-larval shrimp to lower salinities. However, high mortality also occurs at
the end of the production cycle in what producers call "late term mortality". The cause for these mortalities still needs to be elucidated.

In summary, to reduce mortalities in all cultured species in Alabama, producers need on-farm commercial level research and results-oriented on-farm demonstrations to improve the aquaculture techniques that address issues of importance to west
Alabama producers.

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

The target audiences reached through project efforts include 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.

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

The goal of this Hatch project is to reduce disease outbreaks on aquaculture facilities by conducting epidemiology studies and research, to develop management strategies on aquaculture farms through research and demonstration. To accomplish this goal, the following objectives should be met:

1. Develop a research program to determine the on-farm environmental epidemiology factors consistent or correlated to disease outbreaks. Surveys of farms with disease outbreaks are being conducted on an annual basis.
2. Viral and bacterial loads in production ponds (water and soil) We are currently measuring the viral loads in ponds that have been drained and renovated and those that have not been renovated to compare the two.
3. Water quality before disease outbreaks Most producers have started to measure water quality, but not frequently enough to correlate water quality with disease outbreaks.
4. Fingerling sources We are compiling a list of fingerling sources for ponds that do experience disease outbreaks.
5. Feeding amounts and methods Farmers feed once a day and those raising hybrid catfish often put substantial amounts of feed into the pond in an effort to get the fish to grow faster. We have conducted verification methods on these feeding practices and essentially concluded that large amounts of feed lead to high ammonia in the ponds, which reduces feeding and
growth in the fish.

Develop management techniques that minimize conditions necessary for disease outbreaks
We are currently examining the source of fingerlings as well as when they are stocked as possible precursors to disease outbreaks.

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 this reporting period, this project has provided a total of one graduate student (M.S.) with applied training in aquaculture production, animal husbandry, water quality, disease identification, and statistical analyses. It has also offered the
graduate student hands-on opportunities to carry out applied aquaculture research in several sub-disciplines on commercial catfish and shrimp farms in west Alabama. In addition, there have been opportunities granted to travel and present at various regional and national meetings. Opportunities made available to the student have also been provided to the Research Assistant, Research Associate, and Postdoctoral researcher working with me on this Hatch project. In addition to professional meetings opportunities, workshops and industry association meetings have also been provided to producers to understand the importance of water quality, economic factors affecting catfish production, and antibiotic resistance.

Projects results have been disseminated through many different venues. These include the website at the Alabama Fish Farming Center, Fish Farming News (Extension Newsletter of the Alabama Fish Farming Center), farmer workshops, industry association meetings, industry tours (farms, feed mills, processing plants), conferences (state, regional, national), farm visits, farm demonstrations, telephone calls, e-mails, one-on-one office visits with commercial producers, and Cooperative Extension
Fact Sheets. Due to COVID-19, information has also been primarily distributed via e-mail and zoom meetings.
My research group authored 12 journal publications, six cooperative extension fact sheets, and six extension newsletters and popular articles in 2021. Fifteen presentations were given at regional and national meetings, while six extension and workshop presentations were also presented during the reporting period. During the reporting period, I conducted 141 farm visits to interact with stakeholders directly.

During the next reporting period, the plan follows the approach and methods outlined in the original 5-year proposal (2020-2025). To date, no significant changes to the project objectives, goals, and direction have occurred. Several peer-reviewed journal publications 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 by our group in the next year of the project, including experiments and on-farm demonstrations with catfish, largemouth bass, marine shrimp, and crayfish.

Journal Articles Published 2021

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Riley RP, Kelly AM, Roy LA Fernandez-Figueroa EG, Gladfelter MF, Belfiore AP, Wilson AE. 2021. Microcystis blooms in Alabama Aquaculture. Alabama Cooperative Extension Fact Sheet. ANR-2757. 5 pp.

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Hanson T, Roy L, Kelly AM. 2021. 2020 Alabama Farm-Raised Catfish Industry Highlights. Alabama Cooperative Extension Fact Sheet, ANR-2441. 2pp. (revision)

Roy LA, Kelly AM. 2021. Antibiotic feeds for catfish farmers. Alabama Cooperative Extension Fact Sheet. ANR-2762. 4pp.

Kelly AM, Roy LA. 2021. Using medicated feeds in catfish aquaculture. Alabama Cooperative Extension Fact Sheet. ANR-2758. 3pp.

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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.

The west Alabama aquaculture industry is very unique. In addition to being one of the largest strongholds of the U.S. catfish industry, this region also possesses commercial farms that are raising crawfish, sportfish (largemouth bass, grass carp, bluegill,
sunfish, shad) and marine shrimp (Pacific white shrimp, Litopenaeus vannamei) using inland low salinity artesian groundwater.
The potential of this low salinity groundwater source is still largely untapped, although commercial producers have successfully
raised, on a pilot scale, a number of additional euryhaline marine species including blue crab, bull minnows, pinfish, striped mullet, southern flounder, Florida pompano, and red drum (Phelps et al. 2009; Roy et al. 2010a; Roy et al. 2012).

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.

Catfish farming represents the largest segment of Alabama aquaculture (120 million pounds of catfish produced on 77 farms and 17,450 water acres) and comprises 33% of the U.S. catfish industry. The catfish industry is a major economic driver in the Black Belt region of Alabama and is responsible for over 2,600 jobs and a total sales output of 465 million dollars (Hanson et al.
2017). This industry is concentrated in Hale, Dallas, Perry, Marengo, Sumter, Greene, and Pickens counties in west Alabama.
While much work has been accomplished since the inception of the catfish industry several decades ago, largely at Land Grant Universities in catfish producing states (Auburn University, Mississippi State University, and the University of Arkansas at Pine Bluff) and the USDA ARS Warmwater Aquaculture Unit in Stoneville, Mississippi, there is still production-related research that is
necessary to increase the sustainability of the U.S. catfish industry in the present day. According to commercial producers in west Alabama, the primary problems affecting the west Alabama catfish industry include toxic algae, various diseases (virulent
Aeromonas hydrophila, Columnaris, enteric septicemia of catfish), seining inefficiency, large size variability at harvest ("big fish"), competition from international (basa, tra, pangasius, tilapia) and domestic (tilapia) competitors, and low catfish prices. In
addition to these problems, farmers are also interested in alternative pond-based production systems (intensively aerated ponds; split ponds, partitioned aquaculture systems) and alternative species.
Since the beginning of the west Alabama marine shrimp industry in 1998 there have been production-related issues that hindered profitability of these small rural farms in west Alabama (Roy et al. 2010). Inland low salinity artesian well water serves
as the water source for semi-intensive shrimp production in earthen levee ponds in west Alabama. This water source is deficient
in potassium (K) and magnesium (Mg). Shrimp farmers must amend culture water with fertilizers containing K and Mg (Saoud et
al. 2003; McNevin et al. 2004; Roy et al. 2010a). This is typically accomplished with muriate of potash (agricultural grade potassium chloride) and K-Mag® (potassium magnesium sulfate) (Roy et al. 2010a). While Pacific white shrimp can survive in low salinity water, they are native to coastal waters in which the proportion of major cations and anions is similar to full-strength
seawater. The requirements for individual ions are not known exactly but maintaining a sodium to potassium ratio (Na:K) similar
to that of seawater while also maintaining aqueous Mg levels greater than 20 mg/L has resulted in improved survival and production of shrimp reared in this water source (Roy et al. 2010a). While aqueous levels of K and Mg, as well as Na:K ratios, have been examined at length there are still issues related to poor survival following acclimation and stocking of post-larval shrimp to production ponds (Roy et al. 2009).

In recent years, farmers have reported overall farm survivals as low as 28-40% (Dr. David Teichert-Coddington, Greene Prairie Aquafarm, personal communication). Prior to 2014, survival typically ranged from 60-70%. While some of the mortality has been labeled "late term" mortality near the end of the production cycle, a portion of the mortality is attributed to the acclimation
of shrimp down to lower salinities. Often, acclimation is conducted at the post-larval nursery stage and practical trials on the farm using lower cost mixed salt solutions have not been very successful in replacing the more costly varieties. The production
season for inland low salinity shrimp farmers in west Alabama is from May to October. Post-larvae are typically brought to the farm in May and acclimated to pond conditions for 7-14 days in greenhouses. Production ponds are stocked in early June and harvested by the middle of October. This production system paradigm has been successful for Alabama shrimp producers but

there is still quite a bit of mortality documented during the acclimation phase as well as in the first few weeks following stocking.
In summary, in order to provide support to existing commercial catfish, crawfish, and sportfish farmers, and farmers raising euryhaline marine species there is a need for continued on-farm commercial level research and results-oriented on-farm demonstrations to improve aquaculture production techniques and support commercial aquaculture producers in west.

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

The target audiences reached through project efforts include 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.

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

The goal of this Hatch project is to make warm water and inland low salinity aquaculture sustainable and profitable long-term in west Alabama. In order to accomplish this goal, production techniques and practices need to be optimized at the farm level through research, demonstration, and ultimately technology transfer. In order to accomplish this goal the following objectives should be met:

1. Develop a research program to optimize warmwater production practices 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, and baitfish.
Warmwater aquaculture research carried out over the project period was focused on catfish production. One project focused on evaluating the age of channel and hybrid catfish using otolith aging techniques while also surveying farmers to evaluate the cost of different strategies to reduce the occurrence of big fish (too large to be considered market size by the processor) on commercial farms. Recently, an electrofishing boat was purchased and another graduate student was hired to further investigate the issue of big carryover fish on catfish farms. Data generated from a 2019/2020 survey were analyzed to determine the economic impact, regulatory cost, and degree of technology adoption by the US catfish industry, including Alabama. A number of peer-reviewed articles are currently in press from this effort. In 2021, a project was initiated to develop partial enterprise budgets for pond renovation in order to determine the cost of this endeavor for commercial farmers. Efforts are also underway to support a project from another faculty member that is evaluating anti-microbial resistance in pond soils in commercial ponds that have been renovated and comparing them to ponds that have not been renovated. Another study is examining anti-microbial resistance in catfish offered the three different antibiotic feeds used by the catfish industry. In collaboration with a faculty member on campus, my laboratory is carrying out research at a fish processing plant to evaluate the efficacy of existing protocols and equipment to stun catfish as they are unloaded from fish hauling trucks and carried on conveyor belts for slaughter into the plant. Finally, our laboratory is working with faculty on campus to evaluate alternative amino acid profiles to modify existing commercial diet formulations and the use of kaolin as an ingredient to prevent disease in catfish. A recent bird depredation project that was completed in 2020 has generated a large number of peer-reviewed articles in 2020 and 2021(7) that have been recently published. Two more manuscripts are in preparation from this effort. Several extension articles were also published from the work. Information generated from this study is being used by the U.S. Fish & Wildlife Service to develop possible modifications to existing bird depredation permits.

2. Develop a research program that evaluates optimization of production practices for marine euryhaline species, such as Pacific white shrimp and other euryhaline marine species of interest to commercial producers, raised in inland low salinity artesian well water of Alabama as alternative species.
Two separate experiments were carried out at a commercial shrimp farm and a tank system at the Alabama Fish Farming Center with large shrimp (> 15 g) in order to evaluate survival and growth performance. These experiments were designed to explore the late term mortality issues being experienced by commercial shrimp producers in Alabama and the southeastern US. Samples were also taken of shrimp hemolymph to evaluate physiological markers of stress associated with rearing large shrimp at suboptimal ionic profiles. Water that supplied one tank system had been superdosed with additional magnesium while the other tank system was run with water that received the traditional amount of magnesium fertilizer. This study was a repeat of a trial from 2020 that had high mortality. A pond study was also repeated in 2021 in which two different treatments of magnesium supplementation were examined (traditional amount and four times the amount of Mg fertilizer (4x Mg). The control treatment evaluated 6 ponds while the 4x Mg treatments had four ponds. Throughout the experiment monthly samples
of shrimp and hemolymph were taken for future analysis. At harvest survival, food conversion ratio, and yield were measured for each pond. This project is still currently underway and results will be reported in 2022. A graduate student was hired to support this effort in 2021. Support was provided to commercial shrimp farmers by measuring levels of potassium,

magnesium, sodium, and calcium in their pond water to determine the ionic profile of production ponds. Following this analysis, recommendations were provided to shrimp producers in order to correct mineral deficiencies in culture water with agricultural fertilizers containing potassium and magnesium.
A project was in collaboration with faculty in the School of Forestry and Wildlife Sciences (Auburn University) and the scientists at the U.S. Department of Agriculture National Wildlife Research Center at Mississippi State was continued in 2021 to evaluate the impacts of bird depredation on shrimp farms in Alabama and Florida. During 2020 and 2021, a sampling protocol was designed and implemented to collect waterbirds on commercial shrimp farms.
Support was provided to Dr. Anita Kelly's laboratory (also based out of the Alabama Fish Farming Center) for a number of applied studies including the use of kaolin clay in diets to improve shrimp health, demonstrations with amendments to reduce
toxic algae on commercial farms, monitoring of "white livers" on commercial catfish farms, a largemouth bass hatchery study, and an anti-microbial resistance project with catfish.

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 reporting period, this project has provided a total of four graduate students (3 M.S., 1 Ph.D.) with applied training in
aquaculture production, water quality, and statistical analyses. It has also provided graduate students with hands-on opportunities to carry out applied aquaculture research in a number of sub-disciplines on commercial catfish and shrimp farms
in west Alabama. There have been opportunities granted to travel and present at various regional and national meetings. Opportunities made available to students have also been provided to the Research Assistant, Research Associate, and Postdoctoral researcher working with me on this Hatch project. In addition to professional meetings, opportunities for workshops and industry association meetings have also been provided.

Projects results have been disseminated through a number of different venues. These include the website at the Alabama Fish Farming Center, Fish Farming News (Extension Newsletter of the Alabama Fish Farming Center), farmer workshops, industry association meetings, industry tours (farms, feed mills, processing plants), conferences (state, regional, national), farm visits, farm demonstrations, telephone calls, e-mails, one-on-one office visits with commercial producers, and Cooperative Extension Fact Sheets. Due to COVID-19 information has also been largely distributed via e-mail and zoom meetings.

My research group authored a total of 15 journal publications, 6 cooperative extension fact sheets, and 6 extension newsletter and popular articles in 2021. A total of 22 presentations were given at regional and national meetings while 6 extension and workshop presentations were also administered during the reporting period. I personally carried out 81 farm visits during the reporting period to directly interact with stakeholders.

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.

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Pattillo DA, Cline DJ, Hager JV, Roy LA, Hanson TR. 2021. Knowledge levels and training needs of aquaponics stakeholders. Journal of the National Association of County Agricultural Agents. 14(2): 12pp. https://www.nacaa.com/journal/13f2ff94-8c27-4749-bbaf-53d6285bbdd8

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Riley RP, Kelly AM, Roy LA Fernandez-Figueroa EG, Gladfelter MF, Belfiore AP, Wilson AE. 2021. Microcystis blooms in Alabama Aquaculture. Alabama Cooperative Extension Fact Sheet. ANR-2757. 5 pp.

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NIFA Support Acknowledged

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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

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

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

Viral, bacterial, and eukaryotic genomes encode a myriad of small and large noncoding RNAs (ncRNAs). The ncRNA molecules associate with proteins to form ribonucleoprotein complexes that play critical roles in the life cycles of many pathogens. Understanding ncRNAs interactions with their protein ligands is essential for the development of novel drugs against these pathogens.

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.

Some of my research will focus on transfer RNAs (tRNAs) and aminoacyl-tRNA synthetases, necessary components of every protein synthesis apparatus. Another group of complexes, which I plan to investigate, involves tRNAs and toxins acting as tRNAses. These molecules play critical roles in Contact-Dependent growth Inhibition (CDI), an interbacterial communication system that facilitates biofilm formation, persistence and virulence in many pathogenic bacteria, including the non-O157 Shiga toxin producing Escherichia coli SteCO31. I will also explore interactions between bovine ribosomes and Internal Ribosome Entry Site RNA, a noncoding segment of Bovine Viral Diarrhea Virus (BVDV) RNA genome. These interactions play an essential role in the lifecycle of BVDV, a significant pathogen associated with many gastrointestinal, respiratory, and reproductive diseases of cattle worldwide. Finally, I will investigate complexes between ncRNAs and their protein ligands that are produced by African Swine Fever Virus (ASFV), Epstein-Barr Virus (EBV), Kaposi Sarcoma Herpes Virus (KSHV), Hepatitis C Virus (HCV), and Ebola Virus. All ncRNA:protein complexes will be assembled using in vitro synthesized RNAs and proteins overexpressed in bacterial cells. The RNA structures will be investigated using the Selective 2-Hydroxylacylation Analyzed by Primer Extension (SHAPE) approach. The structures of ncRNA:protein complexes will be determined using X-ray crystallography. This new knowledge will provide a foundation for the development of novel therapeutic agents against viral and bacterial pathogens that cause devastating diseases in domesticated animals, foodborne disease outbreaks, and severe medical conditions disproportionally affecting the health and productivity of people living on the farm.

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

Researchers at the 2021 American Institute of Chemical Engineers (November 7-19, 2021, Boston, MA) and the 2021 Biomedical Engineering Society Meeting (October 6-9, 2021, Orlando, FL).
All employees and students of the Auburn University College of Agriculture.

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

Every year, tens of thousands of Americans get sick from diseases spread between animals and people. The CDC, the USDA, and the DOI developed a One Health Zoonotic Disease Prioritization program that focuses on eight groups of diseases. One group of diseases is caused by coronaviruses that target both humans and animals (e.g., SARS, MERS, and PDCoV). New treatments are needed to stop the COVID-19 pandemic, as SARS-CoV-2 continues to mutate and infect people, despite vaccine efficacy. Therefore, in 2021, we focused our research primarily on developing (a) drugs that target RNA-protein interactions essential for viral replication and (b) platforms for controlled drug delivery. Moreover, we continued to investigate the structure of the Internal Ribosome Entry Site (IRES) RNA of Bovine Viral Diarrhea Virus (BVDV).

(a) The SARS-CoV-2 RNA transcription complex as an antiviral drug target

The RNA transcription complex (RTC) from SARS-CoV-2 recognizes and processes RNA for two principal purposes. The RTC copies viral RNA for virus propagation and for ribosomal transcription of viral proteins. To accomplish these activities the RTC mechanism must also conform to many imperatives, including RNA over DNA recognition, base pairing, distinguishing viral and host RNA, production of mRNA that conforms to host ribosome conventions, interface with the error checking machinery, and evading host immune responses. In addition, the RTC discontinuously transcribes specific sections of viral RNA to amplify certain proteins over others. The RTC structure is therefore dynamic and sophisticated. We have conducted a systematic structural investigation of three components that make up the RTC: Nsp7, Nsp8, and Nsp12 (also known as RNAdependent

RNA polymerase (RdRp)). We have solved high-resolution crystal structures of the Nsp7/8 complex providing insight into the interaction between these proteins. We have used small-angle Xray and neutron solution scattering (SAXS and SANS) on each component individually, as pairs and higher-order complexes, and with and without RNA. Using size exclusion chromatography and multi-angle light scattering coupled SAXS (SEC-MALS-SAXS), we defined which combination of Nsp7, Nsp8 and Nsp12 form transient or stable complexes. We used contrast matching neutron scattering to mask specific complex-forming components to test whether components change conformation upon complexation. Altogether, we find that individual Nsp7, Nsp8, and Nsp12 structures vary when other proteins in their complex are present. Combining our crystal structure, atomic coordinates reported elsewhere, SAXS, SANS, and other biophysical techniques, we provided greater insight into the RTC assembly, mechanism, and potential avenues for disruption of the complex and its functions. Developing a mechanistic understanding of the RTC structure will provide detailed insight into how current drugs inhibit the RTC and potential ways to interfere with the RTC functions.

In February 2021, we published our studies on Tipiracil, the first anti-COVID drug targeting viral endonuclease. We applied for an international patent to protect our discovery. As most efforts are focused on developing antivirals that target SARS-CoV-2 Nsp12 protein, our work provides a new avenue for developing novel anti-COVID therapies.

(b) Nanoparticles as novel drug delivery platforms

Nanoparticles offer significant advantages over conventional drug delivery in terms of high stability, high specificity, high drugcarrying

capacity, the ability for controlled release, the possibility to use in different routes of administration, and the capability to deliver both hydrophilic and hydrophobic drugs. Recent technological advancements in nanotechnology and nucleic acid chemistry were instrumental in developing highly effective mRNA COVID vaccines. Recent developments demonstrate that, unfortunately, vaccines alone will not get us out of the COVID. On December 22, 2021, the U.S. Food and Drug Administration issued an emergency use authorization (EUA) for Pfizer's Paxlovid, an oral antiviral drug. The safety and effectiveness of Paxlovid for the treatment of COVID-19 continue to be evaluated. Possible side effects of Paxlovid include impaired sense of taste, diarrhea, high blood pressure, and muscle aches. Paxlovid is not recommended in patients with severe kidney or severe liver impairment.

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, we took advantage of the DNA-gated mechanism by which DNA oligonucleotides physically block the release of encapsulated drugs from porous nanoparticles. We extended this mechanism to be used with drugs bound to the surface of DNA-capped gold nanoparticles (AuNPs). We 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). We observed that varying DNA architectures on AuNPs result 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 drugs quickly. However, even vertical DNA layers prevent drug diffusion at longer sequence lengths. We 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.

(c) The Internal Ribosome Entry Site (IRES) RNA as a target for therapeutic intervention
The Internal Ribosome Entry Site (IRES) RNA of Bovine viral diarrhea virus (BVDV), an economically significant Pestivirus, is required for the cap-independent translation of viral genomic RNA. Thus, it is essential for viral replication and pathogenesis. We applied a combination of high-throughput biochemical RNA structure probing (SHAPE-MaP) and in silico modeling approaches to gain insight into the secondary and tertiary structures of BVDV IRES RNA. Our study demonstrated that BVDV IRES RNA forms in solution a modular architecture composed of three distinct structural domains (I-III). Two regions within domain III are engaged in tertiary interactions to form an H-type pseudoknot. Computational modeling of the pseudoknot motif
provided a fine-grained picture of the tertiary structure and local arrangement of helices in the BVDV IRES. Furthermore, comparative genomics and consensus structure predictions revealed that the pseudoknot is evolutionarily conserved among many Pestivirus species. These studies provide detailed insight into the structural arrangement of BVDV IRES RNA H-type pseudoknot and encompassing motifs that likely contribute to the optimal functionality of viral cap-independent translation elements.
The flexible and dynamic nature of RNA structures represents one of the challenges associated with targeting RNAs with small molecules. However, the ability to identify small molecules that bind to specific RNA targets through structure-based approaches that take dynamics into account provides a viable avenue to identify potent binders. Pseudoknots display unusual
structural stability compared to other RNA motifs. Therefore, our findings are likely to facilitate the development of novel drugs
against BVDV.

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 work presented in the accomplishments section involved three graduate students and one postdoctoral researcher working in three collaborating laboratories:
Robert J. Mosley (graduate student/ Rowan University)
Matthew Talarico (graduate student/ Rowan University)
Devadata Gosavi (graduate student/ Auburn University)
Ricky Whitener (postdoctoral researcher, now at Karamedica, Inc.)

The above listed students presented their research at the following conferences:
Robert Mosley, Mark E. Byrne, and Jacek Wower, Programmable Biohybrid Nanocarriers for the Sustained Release of Cancer Therapeutics, 2021 American Institute of Chemical Engineers (AIChE) Annual Meeting, November 7-19, 2021, Boston, MA.
Matthew Talarico, Jacek Wower and Mark E. Byrne, Theophylline-Selective Riboswitch for the Controlled Release of Intercalated Daunomycin, 2021 American Institute of Chemical Engineers (AIChE) Annual Meeting, November 7-19, 2021, Boston, MA.
Robert J. Mosley, Jacek Wower and Mark E. Byrne (2021) Modulating DNA Architecture on Gold Nanoparticle Surfaces: A Novel Mechanism for Controlled Therapeutic Release. 2021 Biomedical Engineering Society Meeting (BMES), October 6 -9, 2021, Orlando, FL.

Due to COVID-19, we have chosen to participate only in two conferences (for details see "opportunities for training" section).
We published all our data as peer-reviewed articles in scientific journals.
Auburn University media promoted our research. "The Seasons Magazine," the official magazine of the Auburn University College of Agriculture, published in Spring 2021 issue (pages 63-64) an article entitled "ALTERNATE SOLUTION. Professor publishes paper exploring possible cheaper, more efficient solutions to COVID-19."

We will continue our search for antivirals against SARS-CoV-2. RNA-binding proteins nsp7, nsp8, nsp12, nsp13, and nsp15 will be our primary targets.
We will search for small molecules that can bind to BVDV IRES RNA and inhibit BVDV replication.
We will resume our study on the structure of the Ebola virus trailer RNA-human Heat-Shock Protein A8 complex.

Journal Articles Published 2021
Mateusz Wilamowski, Michal Hammel, Wellington Leite, Qiu Zhang, Youngchang Kim, Kevin Weiss, Robert Jedrzejczak, Daniel J. Rosenberg, Yichong Fan, Jan Bierma, Altaf H. Sarker, Susan E. Tsutakawa, Sai Venkatesh Pingali, Hugh M.

O'Neill, Jacek Wower, Andrzej Joachimiak, Greg L. Hura. Transient and stabilized complexation of Nsp7, Nsp8 and Nsp12 in the SARS-CoV-2 replication-transcription complex (RTC) (2021) Biophysical Journal, 2021 Jun 29:S0006-3495(21)00491-4. doi: 10.1016/j.bpj.2021.06.006. Epub ahead of print. PMID: 34197805; PMCID: PMC8238635.

Kim Y, Wower J, Maltseva N, Chang C, Jedrzejczak R, Wilamowski M, Kang S, Nicolaescu V, Randall G, Michalska K, Joachimiak A. Tipiracil binds to uridine site and inhibits Nsp15 endoribonuclease NendoU from SARS-CoV-2. Commun Biol. 2021 Feb 9;4(1):193. doi: 10.1038/s42003-021-01735-9. PMID: 33564093; PMCID: PMC7873276.

Devadatta Gosavi, Iwona Wower, Irene K. Beckmann, Ivo L. Hofacker, Jacek Wower, Michael T. Wolfinger, Joanna Sztuba-Solinska. Insights into the secondary and tertiary structure of the Bovine Viral Diarrhea Virus Internal Ribosome Entry Site. (2021). Preprint available on BioRxiv, DOI:10.1101/2021.05.13.444024

Robert J. Mosley, Julia Hart, Kadie L. Davis, Jacek Wower, Mark E. Byrne. Tailored Nucleic Acid Architectures at Gold Surfaces for Controlled Therapeutic Release. (2021) Langmuir, submitted.

Patent(s) and Plant Variety Protection(s)
PCT/US2021/021913 05/20/2021 Inhibition of Nidoviruses that encode Nsp15

Changes/Problems
We are not experiencing any technical problems.
Due to COVID-related travel restrictions, our interactions with our collaborators are limited to zoom conferences and the exchange of biological samples via FEDEX.

Our future work might be limited by extramural funding. Our collaborators and we, as an interdisciplinary research team, submitted an RO1 proposal to the NIH. Its title: "Mechanism and Assemblies for Replication of SARS-CoV-2."

Closing Out (end date 09/06/2023)

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

Project Director
Xu Wang
Organization
Auburn University
Accession Number
1018100

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

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

Meat, eggs and dairy are animal-based food which 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 of 1) food production animals including cattle, pig, sheep, chicken and fish, 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) Three Ph.D. students in Wang laboratory participated in the research activities; 2) scientists and researchers in academia who are interested in genetic, epigenetic basis of animal disease and animal health, 3) 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, 4) policymakers and funding agencies who highly value the research of sustainable and environmentally friendly approaches for pest control and food animal production.

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

The primary goal of this project is to improve the livestock health and enhance the production efficiency in food production animals.
Objective 1: Elucidate the genetic and epigenetic basis of maternal influence on offspring growth and reproductive success though placental function and epigenetic reprogramming.
Objective 2: Characterize and investigate the genomes and epigenomes of livestock parasites and their biological control agent to provide essential knowledge for developing sustainable approach to control agricultural pests.
Objective 3: Sequence and analyze the genomes of pathogenic viruses and microbes to understand the disease transmission and viral and microbial genome evolution.
Objective 4: Characterize the gut microbiota in normal and diseased animals to understand the metagenomic basis of animal health.

What was accomplished under this goal?
Objective 1: Elucidate the genetic and epigenetic basis of maternal influence on offspring growth and reproductive success through placental function and epigenetic reprogramming.
In 2020, we performed RNA-seq experiments in PND14 (postnatal day 14) uterus samples from gilts received sufficient and insufficient amount of colostrum, indicated by serum immunoglobulin immunocrit (iCrit) ratios in nursing piglets on the day of
birth (PND0). A total of 148 differentially expressed genes (DEGs) were identified between the high- and low-iCrit groups at $P < 0.05$. In 2021, quantitative reverse transcription PCR experiments were performed to verify eright selected DEGs, and all of them were validated. Gene ontology analysis reveals that DEGs with decreased expression in low-iCrit groups are enriched for growth, differentiation, and secretion functions, indicating these important pathways for uterine development were impaired
in animals that received insufficient colostrum at birth. In contrast, immune-related processes, including complement system triggering and cytokine function, are significantly overrepresented in the up-regulated genes in the low-iCrit group. The results
suggest that lacking sufficient maternal antibodies in the colostrum at birth will lead to immune activation in PND14 gilt uterus,
which will affect uterine growth and development, and consequently reduce the adult uterine capacity. The results have been summarized and discussed in a manuscript ready for submission to the journal of Biology of Reproduction.

Objective 2: Characterize and investigate the genomes and epigenomes of livestock parasites and their biological control agent to provide essential knowledge for developing a sustainable approach to control agricultural pests.
It is estimated that a medium-sized dairy farm with ~1,000 cows has the potential to breed 328 million filth flies per day, and a commercial poultry house has a daily fly breeding potential of 64 million. Each fly releases tens of millions of microbes every time they feed. Houseflies can decrease the feeding efficiency by 10-15% in cattle, and stable flies cost $2.2 billion to the livestock industry. Many farms in the US are now utilizing parasitoid wasps as part of the strategy to control filth flies because if it is more environmentally friendly and sustainable, without the rapid development of pesticide resistance. In 2021, we sequenced and assembled the genomes of agriculturally important parasitoid wasp species for biological control, including Muscidifurax uniraptor and Muscidifurax raptorellus. Muscidifurax raptorellus (Hymenoptera: Pteromalidae) is a gregarious species that has received extensive attention for its potential in biological pest control against house fly, stable flies, and other filth flies. It has a high reproductive capacity and can be reared easily. However, genome assembly is not available for M. raptorellus or any other species in this genus, which prevents potential genome manipulations for more efficient biological control. We assembled and annotated a high-quality genome of M. raptorellus, using a combination of long-read (104× genome coverage) and short-read (326× genome coverage) sequencing technologies. The assembled genome size is 314 Mbp in 226 contigs, with a 97.9% BUSCO completeness score and a contig N50 of 4.67 Mb, suggesting excellent continuity of this assembly. Our assembly builds the foundation for comparative and evolutionary genomic analysis in the genus of Muscidifurax, and possible future biocontrol applications.

Objective 3: Sequence and analyze the genomes of pathogenic viruses and microbes to understand the disease transmission and viral and microbial genome evolution.
To explore the molecular mechanisms that contribute to the species adaptation and reassortment of influenza A viruses, our collaborator Dr. Constantinos Kyriakis' laboratory performed 20x individually serially passages of influenza A viruses in human

respiratory epithelial cells. The cell lines were sequenced using the Illumina iSeq100 system to obtain the viral gene sequences for hemagglutinin (HA), neuraminidase (NA), and matrix (M) proteins. Genomic and evolutionary analyses are ongoing to investigate the sequence adaptation after host switch.

Objective 4: Characterize the gut microbiota in normal and diseased animals to understand the metagenomic basis of animal health.
Fescue toxicity causes reduced growth and reproductive issues in cattle grazing endophyte-infected tall fescue. To characterize the gut microbiota and its response to fescue toxicosis, we collected fecal samples before and after a 30-days toxic fescue seeds supplementation from eight Angus×Simmental pregnant cows and heifers. We sequenced the 16 metagenomes using the whole-genome shotgun approach and generated 157 Gbp of metagenomic sequences. Through de novo assembly and annotation, we obtained a 13.1 Gbp reference contig assembly and identified 22 million microbial genes for cattle rectum microbiota. We discovered a significant reduction of microbial diversity after toxic seed treatment ($P < 0.01$), suggesting dysbiosis of the microbiome. Six bacterial families and 31 species are significantly increased in the fecal microbiota (P-adjusted < 0.05), including members of the top abundant rumen core taxa. This global elevation of rumen microbes in the rectum microbiota suggests a potential impairment of rumen microbiota under fescue toxicosis. Among these,
Ruminococcaceae bacterium P7, an important species accounting for ~2% of rumen microbiota, was the most impacted with a 16-fold increase from 0.17% to 2.8% in feces ($P < 0.01$). Functional enrichment analysis revealed that the overrepresented pathways shifted from energy metabolism to antimicrobial resistance and DNA replication after the consumption of toxic fescue seeds. We discovered dramatic microbiota alterations in composition, abundance, and functional capacities under fescue toxicosis. A large number of core species in the rumen, including Ruminococcaceae bacterium P7, are enriched in the rectum microbiome under fescue toxicosis. We hypothesized that the dramatic increase in abundance is caused by readaptation
to the large intestine environment under rumen function dysbiosis due to toxic fescue stress. Our results suggest Ruminococcaceae bacterium P7 as a biomarker with great potential for fescue toxicosis monitoring and management.

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.

Ms. Xiaolei Ma, a Ph.D. student working on the lactocrine insufficiency project in swine, was trained in RNA sample extractions from uterus tissues, RNA-sequencing library construction, transcriptome-wide gene expression analysis, and quantitative PCR validation of differentially expressed genes. She completed a first-author manuscript, which is ready to be submitted to the journal of Biology of Reproduction. She also had the opportunity to present her work at the Department of Pathobiology seminar as well as the Phi Zeta Research meeting.
Mr. Yihang Zhou, a Ph.D. student working on cattle tall fescue toxicosis project, was trained on analysis of whole-genome shotgun metagenomic sequencing data, microbial contig assembly, and gene annotation, as well as the quantitative PCR confirmation of rectum bacterial species with significant abundance changes. He is first author of a manuscript submitted and reviewed at the journal of Microbiome. A revision of this research manuscript is in preparation.
Ms. Xiong Xiao, a Ph.D. student working on the biological control of pest flies using parasitoid wasps, was trained on wasp rearing and diapause, high molecular weight DNA extraction, total RNA extractions, DNA methylome, and transcriptome library preparation, as well as computational analysis of the genomic data. She is the first author of two published peer-reviewed research articles, one in the journal of Genes, Genomes, Genetics, and another one in the journal of Frontiers in Genetics.

Journal Articles Published 2020
Phillips M, Babu JR, Wang X, and Thangiah G (2020). DNA Copy Number and Structural Variation (CNV): Contributions to Adult and Childhood Obesity. Biochemical Society Transactions, BST20200556.

Simora RM, Xing D, Bangs M, Wang W, Ma X, Su B, Khan MGQ, Qin Z, Lu C, Alston V, Hettiarachchi D, Johnson A, Li S, Coogan M, Gurbatow J, Terhune J, Wang X, and Dunham RA (2020). CRISPR/Cas9-mediated Knock-in of Alligator Cathelicidin Gene in a Non-coding Region of Channel Catfish Genome. Scientific Reports, 10, 22271.

Ruan H, Zhou Y, Shen J, Zhai Y, Xu Y, Pi L, Huang R, Chen K, Li X, Ma W, Wu Z, Deng X, WangX, Zhang C, and Guan M (2020). Circulating tumor cell characterization of lung cancer brain metastasis in the cerebrospinal fluid through singlecell transcriptome analysis. Clinical and Translational Medicine, 10(8), e246.

Koehler J, Sandey M, Prasad N, Levy SA, Wang XZ, and WangX (2020). Differential expression of miRNAs in hypoxia ("hypoxamiRs") in three canine high-grade glioma cell lines. Frontiers in Veterinary Science, 7:104.

Journal Articles Published 2021

Lin ZJ, Wang XZ, Wang J, Tan Y, Tang X, Werren JH, Zhang D, and Wang X (2021). Comparative analysis reveals the expansion of the mitochondrial DNA control region containing unusually high G-C tandem repeat arrays in Nasonia vitripennis. International Journal of Biological macromolecules, 166, 1246-1257.

Hicks K*, Tan Y, Cao W, Hathcock T, Boothe D, Kennis RA, Zhang D, Wang X and White AG (2021). Genomic and in vitro pharmacodynamic analysis of rifampicin resistance in multidrug-resistant canine Staphylococcus pseudintermedius isolates. Veterinary Dermatology, 32(3), 219-e67

Ma X, Shang M, Su B, Wiley A, Bangs M, Alston V, Simora RM, Nguyen MT, Backenstose NJC, Moss A, Duong TY, Wang X, and Dunham RA (2021). Comparative Transcriptome Analysis During the Seven developmental Stages of Channel Catfish (Ictalurus punctatus) and Tra Catfish (Pangasianodon hypophthalmus) Provides Novel Insights for the Terrestrial Adaptation. Frontiers in Genetics, 11, 608325.

Ma X, Su B, Bangs M, Alston V, Backenstose NJC, Simora RM, Wang W, Xing D, Li S, Ye Z, Moss A, Duong TY, Wang X and Dunham RA (2021). Comparative genomic and transcriptomic analyses revealed twenty-six candidate genes involved in the air-breathing development and function of the bighead catfish Clarias macrocephalus. Marine Biotechnology, 23(1), 90-105.

Xie Q, Li B, Zhan W, Liu F, Tan P, Wang X, and Lou B (2021). A transient hermaphroditic stage in early male gonadal development in little yellow croaker, Larimichthys polyactis. Frontiers in Endocrinology, 11, 542942.

Tan Y, Wang C, Schneider T, Li H, de Souza RF, Tang X, Hsieh TF, Wang X, Li X, Zhang D (2021). Comparative phylogenomic analysis reveals evolutionary genomic changes and novel toxin families in endophytic Liberibacter pathogens. Microbiology Spectrum, 9(2), e00509-21.

Lü BB, Wu GG, Sun Y, Zhang LS, Wu X, Jiang W, Li P, Huang YN, Wang JB, Zhao YC, Liu H, Song LL, Mo Q, Pan AH, Yang Y, Long XQ, Cui WD, Zhang C, Wang X and Tang X. (2021). Comparative Transcriptome and Endophytic Bacterial Community Analysis of Morchella conica SH. Frontiers in Microbiology, 12, 1821.

Xiong X, Kelkar YD, Geden CJ, Zhang C, Wang Y, Jongepier E, Martinson EO, Verhulst E, Gadau J, Werren JH, and Wang X (2021). Long-read assembly and annotation of the parasitoid wasp Muscidifurax raptorellus, a biological control agent for filth flies. Frontiers in Genetics, fgene.2021.748135.

Journal Articles Accepted 2022

Wang H, Bruce T, Su B, Li S, Dunham RA, and Wang X (2022). Environmental dependent heterosis and transgressive gene expression in reciprocal hybrids between the channel catfish Ictalurus punctatus and the blue catfish Ictalurus furcatus. Biology, in press.

Patel P, Babu JR, Wang X, and Thangiah G (2022). Role of Macronutrient Intake in the Epigenetics of Obesity. Biochemical Society Transactions, advanced online, BST20211069.

Xiong X, Samollow PB, Cao W, Metz, R, Zhang C, Leandro AC, VandeBerg JL, and Wang X. (2022). Genetic and genomic architecture in eight strains of the laboratory opossum Monodelphis domestica. Genes, Genomes, Genetics, 12(1), jkab389.

Data and Research Material

Raw metagenomic sequencing data (Illumina reads) of Eimeria spp. infection on chicken jejunal microbiome have been deposited in the NCBI Sequence Read Archive under the accession number PRJNA601225.

Raw miRNA sequencing data (Illumina reads) of spontaneous high-grade dog gliomas have been deposited in the NCBI Sequence Read Archive under the accession number PRJNA605029.

Raw RNA-seq data (Illumina reads) of spontaneous high-grade dog gliomas have been deposited in the NCBI Sequence Read Archive under the accession number GSE152002.

Raw RNA-seq data (Illumina reads) of whole-body samples of bighead catfish Clarias macrocephalus at seven early developmental stages have been deposited in the NCBI Sequence Read Archive under the accession number GSE151993.

Raw RNA-seq data (Illumina reads) of whole-body samples of Tra catfish Pangasianodon hypophthalmus at seven early developmental stages have been deposited in the NCBI Sequence Read Archive under the accession number GSE154904.

Raw linked-read sequencing data of biological control agent Muscidifurax raptorellus has been deposited in the NCBI Sequence Read Archive under the accession number PRJNA743880.

Raw long-read PacBio sequencing data of biological control agent Muscidifurax raptorellus has been deposited in the NCBI Sequence Read Archive under the accession number SRR15058746.

Raw RNA-seq data (Illumina reads) of live samples from the channel catfish Ictalurus punctatus, the blue catfish Ictalurus furcatus, and their reciprocal hybrids have been deposited in the NCBI Sequence Read Archive under the accession number GSE186603.

Databases
The genome assembly of a biological control agent Muscidifurax raptorellus has been deposited at DDBJ/ENA/GenBank under the accession JAHUUD000000000.

Closing Out (end date 09/06/2023)

Alternative Forage Systems for the Southeastern U.S.

Project Director
Sandra Dillard
Organization
Auburn University
Accession Number
1016411

Alternative Forage Systems for the Southeastern U.S.

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

Forage systems provide low cost feed, protect ecosystem resources, and decrease environmental impact of livestock production. Alabama and other Southeastern states have a temperate climate that is conducive for the year-round growth of annual and perennial forages. Many factors must be considered when developing a forage system including: farm management,
forage species, harvest management, seasonal growth patterns, and end product goals. With current climatic models predicting
more frequent and longer droughty periods, alternative forage systems are critical to the survival of the Alabama forage 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.

This proposal aims to gain better understanding of alternative forage systems for the Southeast U.S. This
will be achieved by focusing on 1) development of agronomic recommendations for novel forage varieties and mixtures; 2) development of agronomic recommendations for grazing of cover crops in a cotton-peanut rotation; and 3) evaluation of the use
of baleage for use in cool-season annual forage mixtures. The data resulting from this proposal will be disseminated to stakeholders through webinars, social media outlets, Alabama Cooperative Extension ANR publications, and field days. These 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 how your target audience benefited from your project's activities.

Results of this project have been disseminated to stakeholders including forage and livestock producers across the US through the Alabama Forage Conference and other producer meetings. As well as researchers and other Extension specialists/agents through peer-reviewed publications and scientific abstracts.

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

The goal of this 5-year project is to develop forage systems that increase the economic and environmental efficiency of forage-based, livestock systems in the Southeast. Specific objectives include: 1) develop agronomic recommendations for novel forage varieties and mixtures; 2) develop agronomic recommendations for grazing of cover crops; and 3) evaluate the use of baleage for use in cool-season annual forage mixtures.

What was accomplished under these goals?
In the southeastern US, equine producers frequently utilize legumes, such as alfalfa (Medicago sativa) and perennial peanut (Arachis glabrata), as forages in their feeding programs. Due to challenges related to production and shipping in the Southeast, producers may be looking for other viable legume options to reduce feeding costs. In the early 1900s, soybean (Glycine max) was a popular legume option in Alabama and may still prove to be a useful legume option. The current study evaluated three forage soybean varieties (V), 'Tower of Leaves' (T), 'Stonewall' (S), and 'Laredo' (L), and two-grain cultivars, 'AG64X8' (A) and 'AG79X9' (X), during the 2019-2020 growing seasons for forage yield and nutritive value. Row spacing (RS; 36 and 71 cm), harvest height (HH; 10, 15, and 20 cm), and location [E.V. Smith REC (EVS) and Wiregrass REC (WG)] were also evaluated. Whole plots were harvested using a small plot harvester. A subsample was dried in a 55°C forced air oven and then ground to 1 mm. Crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) was determined using NIRS analysis. Results were verified by randomly performing wet chemistry analyses on 10% of samples. This study was a randomized, complete block design (n = 4) and statistical analysis was carried out using PROC Glimmix of SAS version 9.4 (SAS Inst., Cary, NC). There was no effect of RS on any parameter evaluated ($P > 0.17$; forage yield, NDF, ADF, and CP). All dependent variables were affected by HH ($P < 0.01$), V ($P < 0.01$), and location ($P < 0.05$). Forage yield was greatest in S and T ($P < 0.02$; 2074 and 1961 kg ha-1
, respectively), while yield was least in L ($P < 0.01$; 1340 kg ha-1). Neutral detergent fiber and ADF were lesser in S than L ($P < 0.01$; 46 and 37 vs 47 and 38%, respectively), T ($P < 0.01$; 46 and 37 vs 47 and 38%, respectively), and A ($P < 0.02$; 46 and 37 vs 47 and 38%, respectively), while X was also lesser than L ($P < 0.01$; 46 and 37 vs 47 and 38%, respectively) and T ($P < 0.03$; 46 and 37 vs 47 and 38%, respectively). Crude protein was greatest in A and X ($P < 0.05$; 16.9 and 16.4%, respectively), while it was least in S and T ($P < 0.05$; 15.8 and 15.7%, respectively).
Harvest height had an inverse relationship with yield, NDF, and ADF, while CP decreased with decreasing HH. EVS had greater forage yield ($P < 0.0001$), CP ($P < 0.0001$), and NDF ($P < 0.05$), but lesser ADF ($P < 0.0001$) than WG. The cultivar 'S' showed the greatest forage yield and the least NDF and ADF, while the CP seen in S was less than other varieties, it was only 1% lower than A, which had the greatest CP. Because of this, S shows the greatest promise as a forage option and should be further tested in mixtures with other forage species.

Commercial N is expensive and can harm the environment if improperly used. Alternative N fertility options are necessary for the long-term sustainability of forage systems. A 2-yr experiment evaluating plant growth-promoting rhizobacteria (PGPR) as an alternative N source for 'Russell' bermudagrass [C. dactylon] and 'KY 31' tall fescue (L. arundinaceum) was conducted in Alabama. Fourteen, 3-m2 plots were treated with full N (56 kg/ha) and ½ N (28 kg/ha), Accomplish LM (AMS), AMS + ½ N, DH44, Blend 20, and a control. DH44 is a single strain of Paenibacillus sonchi, while Blend 20 contains 2 strains of Bacillus pumilus and 1 strain of B. spaericus. Forage samples were taken every 4 weeks with a 0.1-m2 quadrat then analyzed for NDF, ADF, CP, and yield using NIRS. Data were analyzed using Proc GLIMMIX of SAS 9.4 (SAS Inst., Cary, NC) as a completely randomized design (n = 2). For both forages, full N had greater ($P < 0.0139$) yield when compared to the control (tall fescue: 8,295 vs. 7,353 kg/ha; bermudagrass: 9,329 vs. 8,109 kg/ha). There were no differences ($P \geq 0.05$) in NDF concentration for either forage. Full and ½ N had greater CP than AMS in bermudagrass (11.5, 11.4%; $P \leq 0.0490$). Blend 20 treated bermudagrass had greater ADF than full and ½ N(32.7, 30.7, and 30.9%, respectively; $P < 0.0313$). Blend 20 treated tall fescue had greater ADF compared to AMS + N and DH44 (35.8, 12.1, and 33.9%, respectively; $P < 0.0227$). Full N tall fescue had greater CP) compared to AMS (12.1, AMS CP %, respectively; $P < 0.0082$). DH44 had greaterCP compared to AMS and Blend 20 (11.9, 11.0, and 11.0%, respectively; $P < 0.0423$). For both forages, PGPR treated plots produced yields and maintained forage nutritive value similar to that of commercial fertilizer.

Dual-purpose wheat (Triticum aestivum L.) systems increase farm sustainability by diversifying on-farm income.
While these systems are common in the Southern Great Plains of the U.S., they are not often utilized in the Southeast. This study aimed to evaluate pre- and post-grazing herbage mass (HM) of four winter wheat varieties managed under a dualpurpose
grazing and grain production system. The winter wheat varieties evaluated were generic feed-type wheat (mixed variety, Feed), seed-type wheat ('GA Gore'), and two forage-type varieties, 'AGS 2024' (AGS) and 'Pioneer 26R41' (Pioneer).

The experiment was a completely randomized block design with n = 4. Each plot was randomly assigned either as no-grazing (CON) or grazing (GF2). Plots were grazed with cow-calf pairs that were fasted 24 h before each grazing event. Grazing was considered complete when the average stubble height was 10 cm. Herbage mass was determined using three 0.1m2-quadrats per plot and clipping to a 10 cm stubble height before (Pre G) and after (PostG) each grazing event. Forage samples were then dried at 45°C for 72 h. Data were analyzed using PROC GLIMMIX of SAS (SAS Inst., Cary, NC). Differences were declared at $P < 0.05$. Initial HM was greater for PreG than PostG (883 and 615 kg/ha, respectively; $P < 0.01$). Prior to grazing, AGS (1204 kg/ha) was greater ($P < 0.02$) than all other varieties. Pre-grazing, there were no differences among the other varieties (776 kg/ha; $P > 0.14$). Post-grazing, AGS had a greater HM than Seed (788 and 391 ka/ha, respectively; $P = 0.04$), while all other varieties were intermediate (642 kg/ha). Herbage mass was affected by grazing frequency with CON being greater ($P < 0.01$) than GF2 (993 and 691 kg/ha, respectively). These results indicate that both wheat variety and grazing treatment had an effect on dual-purpose wheat herbage mass.

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.

Faculty and students in the program attended several scientific conferences including American Forage and Grassland Council, Southern Section of Animal Science Society, National American Society of Animal Scientists, as well as the Crop Science Society of America National Meeting. This project is associated with six M.S. students and one Ph.D. student, as well as five undergraduate research projects.

This project has been discussed and data reported at field days at two Alabama Agriculture Experiment Station Research and Extension centers and at the statewide Alabama Forage Conference. There were two webinars on the project targeted to Extension agents and producers in the Southeast. Furthermore, results have been discussed at stakeholder meetings including the Alabama Farmers Association and the Alabama Cattleman's Association and at scientific meetings including the American Forage and Grazinglands Conference and the American Society of Animal Scientists-Southern Section meeting.

Year 4 research will continue in objective 2 and further evaluation of novel forage varieties will occur through funded SARE grants. Additional outreach opportunities will be scheduled for 2021 for producer audiences.

Journal Articles Published 2021

Thompson, S.J.*, A. Jacobson, L.S. Silva, S.L. Dillard. 2021. Agronomic responses and sugarcane aphid pressure in warm-season annual forage mixtures. Crop, Forage, and Turfgrass Management. 2021, 20106: 1-7. doi: 10.1002/cft2.20106.

Denman, T.D., D.W. Hancock, S.L. Dillard, N.T. Basinger. J.D. Hale. 2021. Determining the effect of planting date and land preparation method on seedling emergence, forage mass, and forage nutritive value of forage brassica. Agronomy. 11,1184: 1-12. doi: 10.3390/agronomy11061184.

Dillard, S.L., E.D. Billman, and K.J. Soder. 2020. Assessment of forage brassica species for dairy cow and beef cattle fall grazing systems. Applied Animal Science 36:157-166. doi: 10.15232/aas.2019-01921.

Journal Articles Under Review 2021

Shoup, S.L.*, R. B. Muntifering, M.K. Mullenix, L.S. Silva. S.L. Dillard. 2021. Nutritive value and fermentation characteristics of annual cool-season baleage ensiled with or without inoculant. Agronomy.

Conference Papers and Accepted 2021

Carrell, R.C.*, M.K. Mullenix, R. B. Muntifering, A.V. Gamble, and S.L. Dillard. 2021. Impact of cattle removal date on animal and cover crop performance. American Forage and Grazinglands Conference. Savannah, GA.

Cole, M.L.*, R. B. Muntifering, M.K. Mullenix, D.W. Held, and S.L. Dillard. 2021. Plant growth-promoting rhizobacteria (PGPR): effects on 'KY31' tall fescue and 'Russell' bermudagrass nutritive value and yield. American Forage and Grazinglands Conference. Savannah, GA.

Ecology, evolution and molecular basis of plant-bacterial interactions

Project Director

Neha Potnis

Organization

Auburn University
Accession Number
1012760

Ecology, evolution and molecular basis of plant-bacterial interactions

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

Bacterial plant pathogens cause a significant amount of crop loss around the world. Plant pathogenic bacteria have evolved multiple strategies to colonize and infect host plants, in addition to their survival mechanism.

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 emergence of new strains poses problems for disease management and is particularly disruptive to breeding efforts that have focused on race-specific resistance. In this project, bacterial spot of tomato and pepper caused by four diverse Xanthomonas sp. will be used as a model
system to understand the pathogen biology. It is not clear how and why new strains of bacterial spot xanthomonads emerged and, therefore, how it can be prevented or mitigated. Understanding the pathogen population dynamics and emergence of strains with novel pathogenicity factors is necessary for integrated and sustainable management of bacterial leaf spot. Other aspect for this project is aimed at identification and characterization of novel disease resistance genes and their efficacy upon combining with existing disease resistant genotypes. Identification of such combinatorial strategies to mitigate bacterial diseases is important for designing sustainable disease management approaches.

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

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.

Target audiences for this progress report included:
1. Graduate student research in the lab (4 M.S. and 2 Ph.D. students);
2. Undergraduate students through formal classroom teaching and research in the laboratory (Course: General Plant Pathology, Omics in Agriculture) as well as 4 students conducted undergraduate research
3. Growers in Alabama and other neighboring states
4. Research findings were presented by the students and postdoc at national and international meetings.

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

Following objectives have been designed towards the proposed goal.
Obj. 1 Understanding the bacterial spot pathogen ecology and population dynamics on tomato and pepper: During this project period, we continued our extensive field survey of tomato and pepper fields in Alabama, Georgia, North Carolina, and South Carolina. We performed shotgun metagenomics to capture the pathogen diversity and associated phyllosphere microbiome in bacterial spot-infested tomato/pepper fields. Our results indicate that multiple pathogen genotypes can coexist
in the fields. We have also obtained pure cultures of Xanthomonas perforans and X. euvesicatoria from these infected samples. X. perforans was dominant in tomato fields. While X. euvesicatoria was dominant in pepper fields, X. perforans was also recovered from some pepper genotypes. A mixed infection with Pseudomonas was also observed in many fields. Two field trials were conducted in Alabama for evaluating the efficacy of currently employed disease management methods, however, both trials were impacted by tropical storms that hit Alabama.
Obj 2. Understanding the pathogenicity/fitness factors of bacterial spot xanthomonads: We completed writing of a manuscript summarizing findings from the experiments where we compared epiphytic fitness of DtssM-i3* mutant, WT Xanthomonas perforans and complement. This manuscript was accepted after revision in Phytopathology Journal. Briefly, our data revealed that functional TssM belonging to type VI secretion system cluster i3* confers epiphytic fitness to a hemibiotrophic pathogen, by providing higher osmotolerance, enhancing its dissemination, while at the same time, minimizing
overall disease severity.
To understand the contribution of T6SS towards ecology and evolution of Xanthomonas spp., we explored the distribution of

the three distinguishable T6SS clusters, i3*, i3*** and i4, in ~1,500 Xanthomonas genomes, along with their conservation, genetic organization and their evolutionary patterns in this genus. Phylogenetic analysis demonstrated that T6SS clusters i3* and i3*** were likely acquired by the ancestor of the genus Xanthomonas, followed by conservation or loss of individual clusters upon diversification into subsequent clades and that individual T6SS clusters and associated effectors provided a selective advantage to the species during adaptation onto specific hosts. Genetic flux of T6 loci and associated effectors has been common among species and specific combinations of T6SS clusters and repertoires of effectors have been maintained within pathogenic and nonpathogenic species, that inform the role of T6SS in ecological adaptation.
Genome-wide association study revealed the role of carbohydrate metabolism and amino acid transport-associated genes in pepper specificity. Earlier we conducted studies with allele exchange mutations swapping non-functional versions of TonBdependent
receptors in pepper pathogenic strains and functional versions of TonB dependent receptors in pepper nonpathogenic Xanthomonas perforans strains. The functional in planta assays using both infiltration and dip-inoculation method indicated the role of this TonB-dependent receptor during early colonization of the apoplast, possibly to evade recognition by the plant host, thus explaining its pseudogenization in pepper pathogenic strain. We are further exploring the role of cell-wall degrading enzymes and induced immunity in restricting the growth of X. perforans during early colonization on pepper.
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 will be screening the F1 and F2s against X. gardneri. We have also recently sequenced Xanthomonas population obtained from pepper fields. The epiphytic colonization of X. euvesicatoria was observed on resistant pepper cultivars.

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 this project period, as a part of research mentoring, six graduate students and one postdoc 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.

Results from our 2019 and 2020 surveys in Alabama were communicated with the growers during the Alabama fruit and vegetable grower association meeting. For our continued surveys now focusing on microbiome, we have been working with the tomato and pepper growers and extension agents across Alabama, Georgia, South Carolina, and North Carolina. This has provided us opportunities to learn about the current management practices growers have been implementing and see their effects on disease incidence.

During the next reporting period, I plan to continue investigating the proposed objectives. We are conducting spatio-temporal sampling across the southeastern US which will not only provide information on pathobiome but also co-occurring pathogens,
and saprophytic organisms. We will also be able to implement modeling approaches that will allow us to predict risk factors for
bacterial spot disease incidence as well as tap into its evolution. We will continue investigating the host specificity factors in pepper by constructing deletion mutants and conducting in planta assays. We expect to screen F2 crosses with newly identified resistance that can help in the identification of QTLs involved in resistance against Xanthomonas gardneri. New domestic and international collaborations are being developed to explore new areas of research related to plant-microbe interactions.

Products
Journal Articles Published 2021
Liyanapathiranage, P., Jones, J.B., Potnis N. 2021. A mutation of a single core gene, tssM, of type VI secretion system of Xanthomonas perforans influences virulence, epiphytic survival and transmission. Phytopathology. https://doi.org/10.1094/PHYTO-02-21-0069-R

Osdaghi, E., Sharma, A., Goss, E.M., Abrahamian, P., Newberry, E., Potnis, N., Carvalho, R., Choudhary, M., Paret, M., Timilsina, S., Vallad, G., Jones, J.B. A Centenary for Bacterial Spot of Tomato and Pepper. Molecular Plant Pathology, Pathogen Profile. Early View. https://bsppjournals.onlinelibrary.wiley.com/doi/epdf/10.1111/mpp.13125

Potnis, N. 2021. Harnessing Eco-Evolutionary Dynamics of Xanthomonads on Tomato and Pepper to Tackle New Problems of an Old Disease. Annual Review of Phytopathology, 59 (1): null. https://doi.org/10.1146/annurev-phyto-020620-101612.

Stam, R., Gladieux, P., Vinatzer, B. A., Goss, E. M., Potnis, N., Candresse, T., Brewer, M. T. 2021. Population Genomicand Phylogenomic-Enabled Advances to Increase Insight Into Pathogen Biology and Epidemiology. Phytopathology 111 (1): 8–11. https://doi.org/10.1094/PHYTO-11-20-0528-FI.

Shantharaj, D., Williams, M. A., Potnis, N., Liles, M. R. 2021. Burkholderia Gladioli C101 Metabolites Protect Tomato Plants against Xanthomonas Perforans Infection. J Plant Dis Prot, 128 (2): 379–390. https://doi.org/10.1007/s41348-020-00416-9.

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Conference Papers and Published 2021
Liyanapathiranage, P., and Potnis, N. Type VI secretion system of Xanthomonas perforans contributes to the incubation period and is involved in niche adaptation. APS Melhus Graduate Student Symposium 2021.

Bhandari, R., and Potnis, N. 2021. Host genotype affects the microbial community structure on pepper. APS Melhus Graduate Student Symposium 2021.

Liu, R., Castillo, A., Arias-Giraldo, L., Velasco-Amo, M., Almeida, R., Landa, B., Potnis, N., and De La Fuente, L. 2021. Natural competence and homologous recombination among Xylella fastidiosa strains. XF-ACTORS conference Europe 2021.

Arias-Giraldo, L., Potnis, N., De La Fuente, L., Moralejo, E., Velasco-Amo, M.P., Roman-Ecija, M., Imperial, J., Landa, B.B. Detection of recombination events in Xylella fastidiosa genomes of different Spanish strains. XF-ACTORS conference Europe 2021.

Conference Papers and Published 2020
Bhandari, R.*, Potnis, N. Shotgun metagenome sequencing provided intra-specific diversity in bacterial spot Xanthomonads. Tomato disease workshop 2020.

Critical Issue

Global Food Security and Hunger

Alabama Beginning Farmer Program (Including Organic Systems)
Project Director
Ayanava Majumdar
Organization
Auburn University
Accession Number
7001888

Alabama Beginning Farmer Program (Including Organic Systems)

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

To provide basic educational infrastructure and support services to beginning farmers and transitioning producers, including those in underserved communities and military veterans interested in agriculture. This is a multi-team project with a complex communication/marketing plan and evaluation systems.

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

Online long-term educational materials: Farming Basics Online Course (Phase-1 has over 1400 students enrolled, Phase-2 is under development); Farming Basics Phone App (Phase-1 is available with over 1000 installations, Phase-2 is under beta testing); Alabama Beginning Farmer Website (www.alabamabeginningfarmer.com); Alabama IPM/Sustainable AG E-newsletter (3,300+ subscribers) - all these digital media projects are coordinated by Ann Chambliss (Program Assistant) COVID-19 Virtual Events: Virtual Farms Tours (2020 and 2021), Q&A Fridays (2020 and 2021), Commercial Horticulture Webinar Series (2020 and 2021) - Virtual events are being coordinated by Harli Willis (Program Assistant).

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

Our target audience included beginning farmers (<10 years experience), experienced producers (10+years of experience), limited resource and veteran farmers, nonprofit agencies and educators, ACES personnel across five teams (capacity building), crop advisers and retailers, gardeners and community garden managers, farmer market managers, state agencies and field staff.

From 2018-2021 (including COVID-19 pandemic years), the Alabama Beginning Farmer statewide program assisted over 319 producers through the COVID-19 pandemic years through direct on-farm consultation for whole farm planning, and certifications. Overall, these specialty crop producers saved over $144,000 in consultancy fees for crop, pest, and business management services rendered based on the evaluation of records. Success rate of beginning farmers in the program is 70% with over 90% adoption of farming recommendations. Estimated ROI is 10:1 ($10 return for every dollar invested on beginning farmers). This ROI is a very conservative estimate. Testimonials are available upon request.
Main program webpage: www.alabamabeginningfarmer.com

Intensive COVID-19 Virtual Training Events for Diverse Clientele: This is a team activity where the entire commercial horticulture team initiated and participated weekly/monthly training events to benefit producers that cannot attend educational events due to COVID-19 restrictions. The Commercial Horticulture Team completed 52 and 68 events, respectively, in 2020 and 2021 that consisted of the Alabama Virtual Farm Tours, Monthly Webinar Series, and Q&A Friday. In 2020, 1,335 direct and 35,387 indirect participants attended the 68 online events. There were 5,589 engagements and the team answered over 170 questions during the weekly Q&A Friday shows. Social media (Facebook) membership grew 77% with 4,071 followers by the end of the year across three team channels. Demographics included 47% males, 50% females, and 3% others; 84% white, 7% black, 7% Asian, and 2% others. We had 25% new audience, 22% beginning farmers and 10% experienced farmers in online events overall. Flash updates and posts also resulted in 40+ media reports in specialty crop magazines across the southeast. About 125 respondents indicated over $50,000 gain in crops or savings on inputs. In 2021, 52 virtual events were completed in a more organized fashion by the entire commercial horticulture extension team based on 2020 outputs and outcome data. We had 936 direct and 21,652 indirect participants with 158 questions answered via Facebook Live event (Q&A Friday). We had over 7,063 post engagements in 2021 and 117% growth in three Facebook channels since the pandemic started in 2020. We had 14% beginning farmers, 11% experienced producers, 31% urban, community, and home gardeners, and 10% educators among the attendees (65%M, 38%F, 1%Others; 86% white, 12% black, 1% Asian, 1% Others). Innovations in events included bringing 16 guests on Q&A Friday shows, doing ag trivia and giving out 18 prizes, and using horticulture-related cartoons to increase audience engagements (about 5,000 views). Respondents (n=136) indicated 95% usefulness of horticulture crop production and pest alert information since it prevent major crop loss and contamination. We have additional social media metrics available upon request! Availability of the Farming Basics Phone App really helped beginning farmers connect to various team resources and access online archive/video recordings throughout the pandemic.

The Alabama Beginning Farmer and Commercial Horticulture Team could assist producers directly via on-farm, telephonic, and text messaging throughout the pandemic that resulted in prevention of crop failure and input savings for producers. This is the responsive programming offered by the team in addition to planned programing described in Outcomes section.

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

The Alabama Beginning Farmer online and in-person meetings reached a very diverse audience, including farmers from underserved communities across the Black Belt region and military veterans.

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.

COVID-19 posed major challenges to educational events and meetings in-person, especially with older farmers. We depended on technology to assist us. ACES Communications and IT support was great to achieve the results by team! Thanks to them!!

The commercial horticulture team does monthly webinars (open to public) and meets for two hours of team level meetings. All new REAs also received constant mentoring.

We anticipate to see dramatic increase in face-to-face meetings and refinement in social media strategy that have been discussed during the Plan of Work meetings. BFRD program has a very robust and multifaceted evaluation strategy for online/virtual and field events.

Best Management Practices for Alabama Hemp

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002304

Best Management Practices for Alabama Hemp

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

Many hemp growers in Alabama are also new to agriculture and Extension; this has provided ACES an opportunity to connect with additional stakeholders and provide researched based information. Given the uncertain and sometimes difficult to understand legal issues surrounding cannabis on a state and federal level, it is important for ACES to deliver unbiased information to the 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.

We connected with clients who were previously unfamiliar with Extension and provide timely, research-based information to growers around the state. Hemp growers in Alabama how have options for pesticides where previously there were none. We also have provided efficacy data to growers to help manage pests.

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

The target audience was provided unbiased information on hemp management including insect, disease and weed control, and budgeting. Following a hemp Extension meeting, one grower said “They were all informative and offered their numbers to help…I probably would have bought something with the word ‘hemp’ on it and lost money…Now I feel like I can counsel with them instead of paying a $250 consultant fee. So thankful for all the info.”

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

This work has been shared through popular press outlets like NPR which have helped made the public aware of some of the confusing legal status around hemp and cannabis. There is a lot of misinformation out there regarding this plant and the federal and state rules are very hard to decipher. We have helped put out factual information to help not only growers navigate the process but the general public who may be buying cannabis-based products.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to

communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

We have held in-person meetings, virtual meetings, conducted field visits, disseminated handouts at meetings and via email, and taken numerous questions via phone and email to answer grower concerns.

We have conducted in-service trainings on hemp management and disseminated IPM guides, insect identification guides, and enterprise budgets to other Extension personnel.

Improving Peach Production and Marketing in Alabama

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002302

Improving Peach Production and Marketing in Alabama

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 occurance 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.

1. Evaluation of dormancy breaking products during season of low chill accumulation - Dormancy breaking products, hydrogen cyanamide, potassium nitrate, penetrant with dormancy breaking qualities, and combinations of penetrant with either hydrogen cyanamide or potassium nitrate were sprayed at two different stages of chill accumulation (70% and 90% chilling) in an orchard of 'Carolina Gold' peach, which has a chill requirement of 1,050 chill hours. Current results showed that a) the rest breaking products overall are more effective if more chilling is received and b) potassium nitrate can be as effective as hydrogen cyanamide in breaking dormancy. This is important, because hydrogen cyanamide is the leading chemical means of alleviating dormancy and it is a product that is sometimes not available. In addition, the chemical is caustic and poses a health risk. Potassium nitrate is a natural fertilizer and safer to use.

2.Peach variety evaluations - A peach variety evaluation was established at the Chilton Research and Extension Center (CREC) in Clanton, AL in 2012. Commercially released varieties along with experimental and advanced lines are included. This planting provides extremely valuable information related to market season, flowering date, yield potential, disease susceptibility, cold tolerance and over all adaptability to the climate. Data is collected from this planting of peach varieties each year and information is provided to the growers. Additionally, growers are allowed access to the variety trial so that they can assess whether certain varieties or experimental lines will be suitable for their operations.

3. Use of colored plastic mulches to increase plant growth of 'MP-29' rootstock, which is resistant to Armillaria root rot (ARR) - This study used materials such as colored plastic mulch, plastic mulch layer and planting bed formers that are readily available to farmers. Peach trees are typically supplied by nurseries in cooler, more northern locations. The trees are produced on bare ground and planted at extremely close spacing. In this study, 'MP-29' plants were planted at close spacing on raised beds, covered in different colored plastic mulches. It was found that some colored mulches increased plant growth compared to non-plastic covered beds. Additionally, plants with raised on plastic mulch had greater budding success rate compared to non-plastic covered beds. Finally, use of plastic mulches increased growth rate and produced plants ready for sale within 1 year similar to other rootstocks.

These outputs were useful and necessary to both determine the feasibility of innovative solutions to production challenges that challenge sustainability of peach production in Alabama (experimentation) and disseminate our findings at conferences, workshops, webinars, research farm tours, and professional development opportunities for Extension personnel

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

This project addresses two major threats to the peach industry, ARR and climate change. The most sustainable means to address these issues is through breeding. Peach growers can benefit from this research because it is making 'MP-29' more available through protocols developed for on-farm cultivation of the rootstock and overall varietal performance to assist growers in decision making.

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

The peach industry is a leading industry and the most economically important fruit crop industry in the state. Businesses such as Peach Park and Durban Farms, are local entertainment mainstay and popular tourist destination and Durban conveniently located off Interstate 65 are a major generator or revenue and creators of jobs. In addition, other businesses in the area benefit from an increase due to increased foot traffic. The broader public, therefore, benefits from the generation of revenue and creation of jobs.

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.

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 webinars, research farm tours, virtual farm tours, and new and innovative virtual programming.

Sustainable Crops Educational Programs

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002305

Sustainable Crops Educational Programs

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

Accurate pest diagnosis is the first and most critical step in any IPM program. Appropriate IPM recommendations can only be provided once a pest has been properly identified. The Auburn University Plant Diagnostic Lab provides Alabama growers with an unbiased identification of plant problems and management recommendations in order to protect the health and productivity of plants in Alabama's agricultural and natural 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.

Increased grower productivity by responding to issues in real-time. Increased grower knowledge of IPM tactics derived from research-based information. Increased grower awareness of issues before they arise through pest alerts. Increased producer adoption of more sustainable pest management strategies in agriculture.

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

The AU-PDL processed 11,996 samples during 2021. 3,278 of those samples were routine samples (1,695 plant samples, 1,481 nematode samples and 102 insect samples). Throughout the year 1% of clientele are surveyed to determine specific impacts based on recommendations provided through diagnostics. Clients surveyed (n=33) saved an average of $453/sample from

following our recommendations. With 3,278 routine plant samples, the AU?PDL saved clientele $1,484,934. Additionally, of the clients surveyed, 96% indicated they adopted/plan to adopt the IPM recommendations provided by the AU?PDL based on their diagnostics.

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

In addition to diagnostics preformed, we published four peer reviewed journal articles, one extension article, five proceedings at conferences, developed a learning module for the Farming Basics Course, provided 14 presentations to various groups on disease identification and management, identified ten first reports for AL (six of which triggered regulatory actions), provided 13 pest alerts for growers and the industry, consulted on five regulatory action committees for ADAI, maintained USDA certification for testing of three regulated pathogens of concern in our area to assist USDA, ADAI and AL growers, and assisted in the National Clean Plant Network to provide AL citrus growers with clean (disease-free) budwood.

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.

3,278 diagnoses with management recommendations were provided to clientele on a person-to-person basis. Presentations were provided at grower field days, on-farm and at research stations, showing proper pest identification and management strategies. Information dissemination in the form of written and digital materials (e.g., pest alerts, Extension publications, webinars and short videos, mass media articles, Q&A Friday shows). In addition to diagnostics performed and one-on-one training for extension personnel as a result, I also provided three in-service trainings.
Completed two HR courses, participated in 10 workshops/trainings, and attended seven conferences.

Problems encountered in approach: new diseases are constantly being introduced and as so, new diagnostic methods have to be developed. This requires frequent training for staff. With recent covid restrictions across the country, in-person, hands-on training is difficult to obtain.

Sustainable Livestock Systems

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002290

Sustainable Livestock Systems

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

Livestock production system sustainability is an important component of providing high quality, animal-based protein for US consumers, while ensuring renewability of natural resources. 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.

Both online and in-print resources were created on sustainable livestock management practices for use by internal and external stakeholders to address on-farm livestock-forage management questions. This includes online course work, digital publications, website content updates and additions, webinars, videos, and social media resources. There were 11,756 contacts reached through website visits, online course participation, video views, and average social media post reach. Livestock programs, educational resources, and events are highlighted on the website and linked to social media for promotion. There has been increased interaction on our Facebook page since the onset of the COVID-19 pandemic (26% increase in likes/followers since 2020).

There were 50 in-person meetings hosted in 2021 on sustainable livestock systems topics. Meetings varied from multi-night, lecture based series in the classroom to hands-on, field day approaches. One example of success is the Beef Systems Short Course. Since the program began in fall 2019, 207 participants have enrolled in the course across the state (n = 69 in 2021), representing 28,544 acres and 14,212 head of cattle reached by this program. Eight topics were taught over a four-night time period (2 topics per meeting; 45 mins each). Topics included: Forages; Nutrition; Herd Health; Reproduction; Animal Identification, Genetics, and Records; Environmental Stewardship; Economics; Meat Science. A post-program survey was conducted to evaluate 1) potential change in knowledge regarding beef cattle management practices and 2) awareness of Extension resources. The majority of participants were part-time farmers (52%). Overall, producers were highly satisfied with the program with an overall rating of 4.7 out of 5 (Likert-type scale) across program topics, and 67% indicated they planned to adopt one of more of the management practices discussed in their operation within the next 12 months. Top management practices producers planned to implement included: 1) improved forage management (soil/forage testing and grazing management such as rotational stocking), 2) establishing a calving season, 3) record keeping, and 4) proper identification of livestock. 50% of program participants reported that this was their first time attending and Extension program, demonstrating the reach of this program to new and beginning clientele. Total estimated economic impact of the program is $537,950 (based on estimated savings reported per operation; n = 145 responses of 207 participants).

The Animal Science and Forage Extension Team released an e-newsletter in 2021. The newsletter is distributed quarterly and provides timely management information for external stakeholders. Individual articles within the e-newsletter are linked to the ACES website as content pieces. These content pieces can be used as individual references later following distribution of the publication, and serve as a way to archive the information for future reference.

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

Improved understanding and awareness of sustainable livestock systems management practices through product outputs generated from both online and in-person content delivery

Continued connectivity and relationship building with stakeholders through new engagement resources such as the e-newsletter and web content pieces

On-farm application of sustainable animal and land management practices as a result of participating in key programming efforts (i.e. Beef Systems Short Course)

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

Enhanced sustainability of forage-based livestock systems provide value to the broader public through land conservation, ecosystem services supported, and improved animal welfare as part of a safe and secure food supply chain.

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 are disseminated through various forms of communication and program types. Extension specialists and agents provide one-on-one interaction with target clientele (in person through meetings/farm visits or through phone, email or web-based video conference) and group meetings/discussions. Extension educational products created under this plan of work are distributed first through these avenues. Online content is shared through internal Extension listservs, social media, and through commodity group/industry partners for distribution to stakeholders.

Within the Animal Science and Forage Extension team, opportunities for in-service training on beef cattle and forage management practices exist through dissemination of current or recent research trials conducted in the Department of Animal Sciences at Auburn University. Research updates could be delivered as a form of in-service training to Extension agents.

More broad-scale training on sustainable livestock production systems could be offered to Extension personnel (County Extension Coordinators, administrative assistants, etc.) to provide information on the relative importance of livestock production systems to Alabama's economy and share basic resources available through Extension for stakeholders.

Small Ruminant Program- Advantages of Using Forestland for Meat Goat Production

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002381

Small Ruminant Program- Advantages of Using Forestland for Meat Goat Production

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

The current demand for goat meat in the US surpasses domestic supply. However, producers are still facing challenges like dewormer resistant parasites, feed costs, limited knowledge of basic animal production techniques. These constraints hinder producers to meet the current goat meat demand. Alabama is in top five state with a large timber acreage which present an opportunity to integrate goat production with forestland 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.

Several demonstration sessions for landowners and small ruminant producers to educate them about the biological and economic benefits of integrating goat production with forestland management were delivered. One farm field tour, four in-person workshops, and 6 lectures for undergraduate students were delivered. virtual Small Ruminant Webinar Series were delivered . A total of 267 participants registered for virtual sessions and 341 participants attended inperson programs. Additional resources were provided to all program participants, including 376 books and 712 handouts. Also, 8 Extension articles on small ruminant production and management were published on ACES website. Four articles were published in newsletters , reaching 1654 recipients. Finally, six videos were uploaded on Facebook.

This program assisted the audience in getting an understanding of the importance of using goats to control understory vegetations, and also provided basic kowlege to audeince on genaral animal health, reproduction, marketing, nutrition, and forage production management.

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

Results from the demonstration study indicated that goats reduced understory plant cover and invasive weeds species in grazed pastures by 50%. When goats were introduced on forestland and the cost of investment and returns were calculated, the resulting yield was a 20% increase in farm revenue. The information obtained was used as a decision tool to demonstrate to landowners and goat producers how integrating goats in forestland management system can increase profitability and short-term revenue from the sale of the herd.

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

90% of the participants learned new information about goat production and management and were willing to apply skills learned.

Among beginning farmers who participated in alabama goat and sheep summit, 85% of evaluation respondents indicated that they were convinced to bring goats onto their forestland property.

90% of participants indicated they have adopted the use if integrated methods to control internal parasites.

The broader public gained additional options for addressing systemic hunger and increasing profitability while also learning of best practices for forage management.

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.

Due to the continuing Covid-19 pandemic, most communities have limited access for extension personnel to come in and do programming. Most of programs were delivered virtually which presented a challenge to producers especially seniors who were not familiar on using technology or had little or no access to internet. Some of small ruminant educational courses require practical hands on. COVID-19 restrictions prevented educators to reach certain audience when they needed these sessions.

The results were disseminated in workshops, field days, newsletters through print or online.

Herd Health Initiative

Project Director
Raymon Shange
Organization
Tuskegee University
Accession Number
7002767

Herd Health Initiative

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

Most small-scale Cow Calf beef producers in Black Belt and surrounding counties are having difficult times producing quality beef cattle for market. Beef cattle production in the southeastern United States differs in size, practice, and production type from other U.S. regions. These differences are explained in part by climate, primary land use for crops, and forage availability. As a result, consumers pay higher prices at the grocery store, international beef imports demand grow, and locally grown beef supply becomes limited.

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.

Twice yearly TUCEP and Tuskegee University School of Veterinary Medicine provide a series of hands-on small-scale beef cattle herd health management demonstrations though they were only relegated to one because of the pandemic (Oct.-Dec). Two hundred two (202) participants were engaged in the herd health management demonstrations. Additionally, 54 farm visits by TUCEP personnel, and 12 workshop/field days (9 virtual) were held to educate small scale producers in areas such as: Forage and forage grass improvement, nutrition, marketing strategies, catch pen design, cross fencing, beef cattle genetics, year round pasture management, USDA financial programs and technical assistance, farm enterprise budget, and general herding cattle discussion were disseminated by phone, brochures, news articles, local stockyards, technical assistance, workshops, conferences, and one on one contacts. On average, 60% of producers that attended the training events were cow-calf producers, while 12% had stocker operations.

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

Over three hundred producers have been impacted by farm visits, herd health demonstrations, and workshops. Of the producers that have attended the additional training sessions, 85% of producers acknowledge the importance of implementing a herd health protocol. Sixty percent (60%) of producers that have participated in the training opportunities have begun utilizing Expected Progeny Difference Values (EPDS) while selecting bulls for natural mating or artificial inseminations resulting in higher quality calves being produced. All farm visits and training sessions provided a unit on value-added marketing. As a result of these training opportunities, approximately ten producers have decided to work with TUCEP to establish marketing clusters to increase the value of the calves that they market.

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

Ranchers with cow-calf operations were able to interface with the next generation of veterinarian professionals as well as Extension professionals, and current veterinarians in a collaborative manner. Information was shared on line via the Zoom platform, and recently ranchers from 3 neighboring states and 1 neighboring country have reached out to request the

extension of programming to include them in the future, stating that the information provided in the Zoom sessions was excellent.

Closing Out (end date 09/06/2023)

Minimizing Stress and Improving Performance of Grass-fed Beef Cattle

Project Director
Bobwealth omontese
Organization
Alabama A&M University
Accession Number
1024530

Minimizing Stress and Improving Performance of Grass-fed Beef Cattle

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

The overarching goal of this study is to 1) characterize the behavioral and physiological changes in grass-fed beef cattle during the summer months, and weaning; 2) evaluate the effects of melatonin on behavioral and physiological responses of grass-fed beef cattle during the summer months, and weaning; and 3) mentor students by creating immersive learning opportunities in large animal activity monitoring and diagnostic imaging.

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

The research activity and hands-on learning opportunities implemented as a result of this study produced data on the effects of melatonin on weaning and summer heat stress in beef cattle. Also, the research activities allowed 12 undergraduate and 3 graduate students to gain large animal handling and management skills. Overall, the ongoing project has generated useful data that could be used to drive management decisions to improve welfare and performance of grass-fed beef cattle. Results from our study has been presented at the 2022 Annual Alabama A&M STEM day and the 2022 1890 Association of Research Directors conference.

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

Student in the ABHS program were exposed to research design and methodology, research implementation under field conditions, large animal handling and chute management, biological sample collection and laboratory processing, data analysis and conference abstract preparation, etc. Also, students developed skills in the use of activity monitoring technology, advanced diagnostic imaging and health monitoring of beef cattle. Student were trained in the art and science of scientific presentation and won several awards in the 2022 AAMU STEM day meeting. Furthermore, 2 students will be presenting research findings at the 2022 annual ASAS conference. Abstracts include: 1 - #1244254 -- Effects of melatonin on physiological parameters, chute and exit scores in beef calves exposed to summer heat stress; 2 - #1244262 -- Effect of chronic melatonin supplementation during mid to late gestation on performance and behavioral responses of cows exposed to summer heat stress; and 3 - #1244266 -- Effects of melatonin on behavioral and physiological responses of weaned beef calves.

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

Beef cattle producers have learned about adoption of reproductive management strategies for their herd and the use of ultrasound for pregnancy diagnosis. The first ever Alabama Cattlemen meeting was organized to connect minority students with the beef industry in Alabama. This research conducted at the Winfred Thomas Agricultural Research Station has further strenghtened the opportunities for cross fertilization of ideas and communication with beef producers around the research station. Project activities also provided an enabling environment for producers to discuss beef production challenges and opportunities for growth.

Small Farm Outreach and Training Program

Project Director
Raymon Shange
Organization
Tuskegee University
Accession Number
7002766

Small Farm Outreach and Training Program

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

Because of years of USDA program discrimination, minority landowners, farmers and ranchers had suffered debilitating losses of land, profit, and operational capability. These producers in turn had attempted to turn to private loans to help run their operations, but were met with difficult interest rates, lack of collateral, and lack of financial history to fully take part in these lending programs as well. Since the 1990s the USDA has attempted to open up more opportunities for program participation and lending for these producers. Tuskegee University's Cooperative Extension in cooperation with USDA's 2501 (Outreach and Assistance for Socially Disadvantaged Farmers and Ranchers and Veteran Farmers and Ranchers Program) seeks to close these knowledge and application gaps.

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 Small Farmer Outreach Training & Technical Assistance Project (2501 Program) in conjunction with USDA programs provided valuable one-on-one technical assistance to 122 farmers, 5 group trainings, and 10 workshops.

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

The results of this outreach included 50 successful USDA loan applications and credit repair for 12 participants.

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

Being a part of the 1890s Center of Excellence for Farming Systems, Rural Prosperity, and Economic Sustainability allows for this to be shared with other Small Farmer Programs throughout the 1890s system.

Critical Issue

Human Nutrition, Well-being, Health and Obesity

Rural Alabama Vaccination Education and Events (RAVE2) Program
Project Director
Raymon Shange
Organization
Tuskegee University
Accession Number
7002771

Rural Alabama Vaccination Education and Events (RAVE2) Program

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

The COVID-19 pandemic brought existing health, social, and political disparities in the Alabama Black Belt counties to the forefront. Issues with access to programs and resources, generational disenfranchisement, mistrust of governmental and medical agencies, and socioeconomic challenges made this new pandemic a significant challenge for people living in black belt counties. The pandemic occurred during a surge of misinformation and conspiracy theories about everything related to the virus. Distrust in the mitigation strategies championed by federal agencies undermined public health efforts and eroded

the historical relationships between the public, healthcare professionals, and science/health institutions. This led to a high number of excess deaths, despite the availability of resources designed to combat viral transmission and related morbidity/mortality. Navigating this new affront on science and medicine required the rebuilding of trust between the healthcare industry, science, and the people who had the greatest need for support.

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 collaborating with local and state partners, RAVE2 was able to make significant gains in COVID vaccination, testing, adherence to mitigation strategies and improvements in vaccination, testing and vaccine education indices in several of the Alabama Black Belt counties. The program conducted town halls, participated in Zoom informational sessions, and partnered with local organizations at outside community events to share educational material, as well as provide COVID testing, and in some cases “pop-up” vaccination clinics by our partner Rhema Health.

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

In August and September of 2021, the program was able to impact a total of 708 individuals of which 10% were able to get tested, 16 were vaccinated, and all of them received educational information. 90% of respondents stated that the educational information would be useful for them in staying healthy during the pandemic.

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

An increase in awareness, vaccination education, and vaccinations/behavior around health is an asset to the entire nation.

Diabetes Empowerment Education Program (DEEP)

Project Director
Paul Brown
Organization
Auburn University
Accession Number
7002237

Diabetes Empowerment Education Program (DEEP)

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—15 percent of the adult population has diabetes, and more than 1.3 million have prediabetes. In Alabama, approximately 31,000 new cases are diagnosed annually with estimated direct and indirect health care costs of $5.4 billion. Diabetes Empowerment Education Program (DEEP) is essential for people with pre-diabetes, diabetes, and care providers to obtain 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.

Objectives of the 8 hours of diabetes self-management traning were to educate individuals on 1) how to best control their blood sugar, blood pressure, and cholesterol levels; how to establish relationships with primary care providers; how to encourage better nutrition and regular exercise; and how to express the importance of developing support networks of family, friends and existing community-based soical services.The Diabees Empowerment Education Program showed people affected by diabetes how to manage and control their diabetes. It provided excellent information that will help anyone to improve and maintain the quality of life of persons with diabetes or persons who have diabetes risk factors. After the program, 42.42% of the participants check their feet compared to only 38% check their feet in the pre-survey. There were statistically significant increases in physical activity and eating more fruits and vegetables according to pre and post surveys.

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

Diabetes Empowerment Education Program (DEEP) participants who completed at least 5 of the six sessions learn 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.

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

Twenty-five million people, or 8.3% of the U.S. population, have diabetes. Of those, 7 million people don't know they have it. Approximately 610, 458 people in Alabama have diabetes. Diabetes and prediabetes cost an estimated $5.4 billion in Alabama each year. The serious complications include heart disease, stroke, amputation, end-stage kidney disease, blindness and death. The Diabetes Empowerment Education Program (DEEP) addresses these issues directly with participants and to build support networks involving family and friends.

Escape Vapes: Youth Prevention Program

Project Director
Paul Brown
Organization
Auburn University
Accession Number
7002273

Escape Vapes: Youth Prevention Program

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

Escape Vapes: Youth Prevention Program is a program designed for adolescents to prevent their use of electronic cigarettes/pods/mods. Adolescents in 5th through 12 grade (Ages 11-18) are our target audience. There has been a staggering increase among middle and high school students using e-cigarettes. These high-dose nicotine products have been found to be highly addictive and a gateway to traditional cigarettes and other drugs/alcohol. E-cigarettes also cause a number of health issues, in addition to nicotine addiction that has long-term impacts.

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.

After the program, 94% of youth believed that e-cigarettes can be more addictive than traditional cigarettes; only 6% believed that they were less addictive. There were statistically significant increases in knowledge for youth participants in these four areas: 1) Knowledge of how nicotine impacts the brain; 2) Knowledge that one JUUL pod has as much nicotine as one pack of cigarettes; 3) Knowledge of the toxic ingredients in a JUUL pod; and 4) Knowledge of how manufacturers target young people.

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

The target audience was youth (**n = 1,146**) in 5th to 12th grades/ages 11-18. Of the students, 108 (9%) African American/Black, 142 (12%) White, 1 (.08%) American Indian/Alaska Native, 10 (.8%) Hispanic and 1% more than one race. Of the students, 125 (45%) were male, 147 (53%) female and 7 (2.5%) chose not to respond. Of the students, 97 (35%) 5-6 grade, 33 (12%) 7-8 grade, 106 (38%) 9-10 grade and 43 (15%) 11-12 grade.

1. Increased youth knowledge of ingredients in a JUUL pod

Before the program, 21% of youth stated they had no knowledge of the various toxic ingredients in JUUL pods; 27% of youth had a “little” knowledge; 27% had some knowledge; and 24% had “a lot” of knowledge.

After the program, 13% of youth stated they had no knowledge of the various toxic ingredients in JUUL pods, 13% said they had “a little”; 23% said they had “some” knowledge and 51% said they now have “a lot” of knowledge. Out of 279 youth surveyed, 152 youth had a change in knowledge in this area.

2. Increased youth knowledge on how nicotine affects the brain

Before the program, 13% of youth stated they had no knowledge of how nicotine impacts the brain; 49% of youth had a "little" knowledge; 110% had some knowledge; and 107% had " a lot" of knowledge.

After the program, 24% of youth stated that they had “a little” knowledge; 66% said "some" and 174% said "a lot."

3. Increased youth knowledge of how e-cigarette/vaping manufacturers target youth

Before the program, 8% of youth said they did not know about targeting; 17% said they knew “a little”; 25% said they knew “some”; and 50% said they knew “a lot” about targeting.

After the program, only 6% said that they did not know about targeting; 11% said they knew “a little”; 17% said they knew “some”; and 66% said they now know “a lot” about targeting.

4. Increased youth confidence to avoid nicotine products

Before the program, 8% of youth did not have any confidence they could avoid nicotine products; 9% said they had “a little”; 19% said they had “some”; and 64% said they had “a lot” of confidence they could avoid nicotine products.

After the program, only 8% said they did not have any confidence they could avoid nicotine products; 5% said they had “a little”; 19% said they had “some”; and 68% of youth said they were more confident in their ability to avoid nicotine products.

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

The use of electronic cigarettes for youth is rising nationwide and remains a critical public health issue. Escape Vapes is an effective prevention program for increasing knowledge about the risk of vaping. We anticipate that this universal prevention program will complement other initiatives that encourage youth not to vape. As a prevention program, educating youth before they start using electronic cigarettes is important. Youth who are knowledgeable about the risk associated with vaping may be more likely to make informed decisions in the future.

We have an Extension publication that highlights the evaluation results and impact of Escape Vapes that can be disseminated either through print or online.

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.

Due to the ongoing **COVID-19** pandemic, some school settings provided limited access for external educators to do programming. Also, since we are doing online programming, it is often difficult to ensure that everyone has done the survey. Therefore, the data reported is only a subsample of the youth population served.

There is training available for the Escape Vapes program and content area through Dr. Adrienne Duke and through the Stanford University Toolkit (https://med.stanford.edu/tobaccopreventiontoolkit/curriculum-decision-maker/by-module/E-Cigs.html)
Particular members of our team have been trained this year in a youth tobacco cessation program that is implemented through the American Lung Association.

Since we have a prevention program, it is important to now focus on interventions to help youth who have already started vaping. Therefore, starting in 2022, the Nutrition Diet and Health team will be implementing Escape Vapes: Healthy Futures, which is a school-based intervention program for youth who have been caught vaping by school administrators. Instead of suspension, we will provide a programming alternative for schools. In addition to this new school-based programming option, we have a community-based option for vaping intervention. Since vaping is highly addictive, youth need help quitting. Therefore, a few of the Nutrition, Diet, and Health team members and Dr. Adrienne Duke have been trained in NOT (Not on Tobacco), a program designed by the American Lung Association to help youth quit smoking and vaping.

Right Bite: Setting the Table for Healthy Eating

Project Director
Paul Brown
Organization
Auburn University
Accession Number
7002238

Right Bite: Setting the Table for Healthy Eating

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

Alabama has the 7th highest obesity rate in the nation for adults. The rate of obesity for youth in Alabama is 17.2% (high school students). Adults who have obesity, when compared with adults at a healthy weight, are more likely to have a decreased quality of life and have an increased risk of developing serious health conditions including hypertension; Type 2 diabetes; heart disease and stroke; sleep apnea and breathing problems; some cancers; and mental illness such as depression and anxiety. The estimated medical costs of obesity is $342.2 billion (in 2013 dollars). The indirect costs of decreased work productivity tied to obesity are estimated at $8.65 billion per year.

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.

Right Bite: Setting the Table for Healthy Eating provides resources that can help consumers understand the new Nutrition Facts Label and how to use the information it provides to make informed food choices. The program also provides resources that offer realistic tips on how to shop, prepare and order food when eating out to build a healthy diet. Two components were added to the program to teach tips on controlling blood pressure and managing heart disease. Right Bite is taught face-to-face and online.

The Right Bite: Setting the Table for Healthy Eating **reached 1,220 adults.** Of the adults reached, 887 (73%) were female and 328 (27%) males. Of the adults reached, 711 (58%) were African American/Black, 493 (40%) White, 4 (.3%) and 7 (.57) another race.

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

The Right Bite: Setting the Table for Healthy Eating program showed a significant positive difference from pre and post-survey groups. From pre-training to post-training, significantly more participants understood the importance of comparing different items using the Nutrition Facts Label to find the right food for better health. From pre and post surveys, 85% of participants learned to choose items higher in vitamins, minerals and fiber. Participants also showed a 57% increase in planning to use the Nutrition Facts Label before buying something new.

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

The broader public benefits when citizen and community health improves, thus reducing health costs and absenteeism.

ALProHealth: CDC High Obesity Program

Project Director
Sondra Parmer
Organization
Auburn University

Accession Number
7002239

ALProHealth: CDC High Obesity Program

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

According to data from 2020, Alabama has the 3rd highest adult obesity rate (39%) in the United States, and programming to address community factors that influence obesity rate is needed. Community factors include aspects of both the food environment, such as access to affordable, healthy foods, and the physical activity environment, such as access to opportunities for safe and affordable physical activity.

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 following ALProHealth activities occurred in 2021:

- Community coalitions continued or were formed in the CDC-identified counties with an adult obesity rate of 40% or greater.

- Efforts were continued or enhanced in food retail spaces to provide increased geographic or financial access to healthier foods. Food pantry improvements included expanding capacity through the addition of refrigeration, freezers, shelving, storage, fans, and lighting. Retail store enhancements included changes that increased the availability, appeal, and affordability of healthier foods. Farmers market enhancements included purchasing signage, tables, tents, and fans.

- Activity-friendly routes connecting citizens to everyday destinations were created and/or maintained through new or improved plans or policies.

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

Community coalitions catalyzed changes to their food and physical activity environments resulting in places that can better support the health of their citizens. By focusing on policy, systems, or environmental changes that can be made at the local level, coalitions were able to create real, tangible changes that make their communities healthier places to live. Additionally, while increasing personal health is the overarching goal of this project, we realize these activities go beyond personal health and extend into creating places and spaces where people want to live and be. Not only are community coalitions affecting bodily health, but activities directly impact local economic and resource development through creating vibrant communities.

In 2021, all 13 counties participating in ALProHealth developed and maintained 13 community coalitions that served as the local decision-makers. ALProHealth relies on citizens within a community to relay critical needs and barriers that discourage healthy lifestyles. Coalitions are critical to the success of ALProHealth in communities as they are the ones to decide on which activities to implement based on identified needs.

Coalitions increased access to healthy foods by:

- Enhancing 11 places where community members can buy or obtain food, including 5 food pantries, 4 retail food stores, and 2 farmers markets.

- 20,850 people were potentially impacted by increased geographic or financial access to healthier foods

To increase the safety of walking and biking:

- 6 coalitions developed Active Transportation Action Plans that addressed the development of 89 total miles of walking and biking infrastructure, including 33.7 miles of new sidewalks, 2.9 miles of enhanced sidewalks, 6.7 miles of new bike

lanes, 41.4 miles of new shared-use paths, and 4.4 miles of enhanced shared-use paths.

- 14 potential new or enhanced sites, connected by activity-friendly routes, have been addressed by new or improved plans or policies.

- 17 actual new or enhanced sites, connected by activity-friendly routes, were created or enhanced as a result of new or improved plans or policies.

- 83,348 people were potentially impacted by new or improved plans or policies addressing activity-friendly routes to everyday destinations.

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

Because ALProHealth is a community-wide project, the target audience includes all residents within a community or county where changes are being made. However, citizens within the community and the broader public outside of ALProHealth communities will realize 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 can cause.

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.

While we continue to deal with restrictions and disruptions related to COVID-19, engagement with County Extension Coordinators and community coalitions has largely been virtual through Zoom. Planning for active transportation improvements is an activity best done in person, where a city's environment can be experienced firsthand. However, restrictions on travel have made this activity virtual, and ALProHealth has worked closely with external technical assistance providers to accommodate this necessity and brainstorm creative methods by which active transportation improvements can be effectively planned for and implemented.

ALProHealth developed several new techniques for accomplishing goals through a virtual environment. One specific opportunity unique to this past year was the process we undertook for developing active transportation action plans for communities. While additional funding for technical assistance providers was key to creating a final plan, the general process of this work is applicable to any small or medium-sized community that does not have personnel dedicated to this type of work. This includes information on why active transportation improvements are important, who should participate in a coalition, where interventions could be encouraged, virtual engagement through a “photovoice” activity, and resources to put all the pieces together.

Success stories highlighting ALProHealth activities are developed every year as a requirement to our funders, the Centers for Disease Control and Prevention. These stories also serve as convenient snippets to share with communities looking for a quick summary of what has been accomplished. In addition to traditional success stories, ALProHealth began building up a web presence on Alabama Extension’s website, so there can be a central “hub” of information about the program to be shared with stakeholders that may be interested in learning more about the project. In addition to local dissemination, ALProHealth activities and interventions are regularly highlighted through academic presentations at meetings and conferences and through articles developed for peer-reviewed journals.

ALProHealth aims to focus on establishing healthy nutrition standards in key institutions, such as hospitals, afterschool programs, faith-based organizations, food pantries, and early care and education centers. To do this, a greater emphasis will be placed on recruiting community partners that are able and willing to make these changes. Additionally, a greater focus will be placed on maintaining a Communications plan to highlight successes of the program and share previous accomplishments and progress with relevant stakeholders.

Urban EFNEP

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002343

Urban EFNEP

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

Information from the Office of Minority health indicate the Hispanic American women, 78.8 percent are overweight or obese, as compared to 64 percent of non-Hispanic white women. Source: https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlid=70

- Based on the 2020 BRFSS BMI data, 39% of Alabama adults are obese. Source: https://nccd.cdc.gov/BRFSSPrevalence/

- Based on the 2019 BRFSS Fruit/Vegetable consumption data, 49% of Alabamians eat fruit less than one time per day, 22% of Alabamians eat less than one vegetable per day. Source: https://nccd.cdc.gov/BRFSSPrevalence/

- Based on 2019 BRFSS Physical Activity Index, 82% of Alabamians do not participate in enough Aerobic and Muscle Strengthening exercises to meet guidelines. Source: https://nccd.cdc.gov/BRFSSPrevalence/

- In Alabama the 2021 food insecurity data indicates, 1 in 6 Alabamians face hunger. Source: https://www.feedingamerica.org/hunger-in-america/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.

Providing direct education allowed for participants to increase knowledge of nutrition, physical activity, food safety and food resource management. This increase in knowledge led to improved healthy behaviors and improvement in financial condition. Other outputs made available support the lessons learned through direct education and provide opportunities for learning in non-face to face environments.

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

Youth: (n=207)

- 24% of 3rd-5th graders increased vegetable consumption

- 29% of 3rd to 5th graders increased fruit consumption

- 33% of 6th-8th graders increased vegetable consumption

- 25% of 6th-8th graders increased fruit consumption

- 59% of youth participants improved their physical activity practices

Adults: (n=32)

- 96% of participants showed improvement in one or more diet quality indicators (i.e., eating fruits, vegetables, red and orange vegetables, dark green vegetables, drinking less regular soda (not diet), drinking less fruit punch, fruit drinks, sweet tea, or sports drinks, and cooking dinner at home).

- 96% of participants showed improvement in one or more food resource management practices (i.e., cook dinner at home, compare food prices, plan meals before shopping, look in refrigerator or cupboard before shopping or make a list before shopping).

- 79% of participants showed improvement in one or more physical activity behaviors (i.e., exercising for at least 30 minutes, doing workouts to build and strengthen muscles, or making small changes to be more active).

- 68% of participants showed improvement in one or more food safety practices (i.e., washing hands before preparing food, washing all items and surfaces after cutting raw meat or seafood, not thawing frozen food at room temperature or using a meat thermometer).

- 18% of participants showed improvement in one or more food security indicators (i.e., not eating less than you wanted so there was more food for your family or having enough money to get food for your family).

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

The broader public benefits from the advancement of these objectives in the following manner:

• Improvement in individual health can improve public health status, i.e., stronger immunity, disease resistance, reduced transmission of disease.

• Improvement in health can result in reduce healthcare cost for employers related to healthcare, workers compensation, absenteeism, and correlate into improved productivity.

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.

Programming reach was reduced due to the continued COVID19 pandemic resulting in sporadic school closures, stay at home quarantine orders, etc. Programming efforts were toggled between in person and virtual platforms as appropriate while adhering to program guidelines.

Outcomes are included in Alabama Extension Impact Reports available to public at large via print and on ACES webpage. Results and outcomes are reviewed by funders with recommendations for program improvements to help develop program initiatives to meet the need of our target audience.

Urban SNAP-Ed
Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002341

Urban SNAP-Ed

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

Through Alabama A&M University the Urban Supplemental Nutrition Assistance Program-Education (USNAP-Ed) program the target population eligible to receive nutrition education and obesity prevention services continues to focus on SNAP participants and low-income individuals eligible to participate in SNAP or other means-tested Federal assistance programs. Urban SNAP-Ed is designed to empower limited-resource families and individuals to make wise food choices, to select and prepare safe food, and to consume a nutrient dense diet of healthy foods. Participant sites include senior centers, public housing, community centers, food banks, WIC/DHR, after-school programs, Boys & Girls Club, Girls Inc.
It is important because this audience is often un/underserved regarding having access to these educational opportunities. The prevelance data on these topic related issues in Alabama supports providing education focused on healthy dietary habits, physical activity, food resource management, and food safety.
• Based on the 2020 BRFSS BMI data, 39% of Alabama adults are obese. Source: https://nccd.cdc.gov/BRFSSPrevalence/
• Based on the 2019 BRFSS Fruit/Vegetable consumption data, 49% of Alabamians eat fruit less than one time per day, 22% of Alabamians eat less than one vegetable per day. Source: https://nccd.cdc.gov/BRFSSPrevalence/
• Based on 2019 BRFSS Physical Activity Index, 82% of Alabamians do not participate in enough Aerobic and Muscle

Strengthening exercises to meet guidelines. Source: https://nccd.cdc.gov/BRFSSPrevalence/
• In Alabama the 2021 food insecurity data indicates, 1 in 6 Alabamians face hunger. Source: https://www.feedingamerica.org/hunger-in-america/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.

Providing direct education allowed for participants to increase knowledge of nutrition, physical activity, food safety and food resource management. This increase in knowledge led to improved healthy behaviors and improvement in financial condition. Other outputs made available support the lessons learned through direct education and provide opportunities for learning in non-face to face environments.

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

1. 2,939 participants involved in USNAP-Ed classes, 50 program sites and community partnerships established

There were 377 adult participants that completed pre, post and 3-month delayed post assessments. Of those participants, the change in behavior and condition is reported as such:
• 32% increase in adult participants who eat more than one KIND of fruit a day
• 33% increase in adult participants who eat more than one KIND of vegetable a day
• 28% increase in physical activity among adult participants
• 38% increase in adult participants who use a grocery list
• 37% increase in adult participants who use coupons to save money
• 33% increase in adult participants that DO NOT run out of food before the end of the month

There were 1425 youth participants that completed pre, post and 3-month delayed post assessments. Of those participants, the change in behavior and condition is reported as such:
• 25% increase in youth participants who eat more than one KIND of fruit a day
• 45% increase in youth participants who eat more than one KIND of vegetable a day
• 38% increase in physical activity among youth participants

2. Community garden efforts continued this year with gardens being replanted, with 63 participating and 108 pounds harvested.
3. Social Marketing Billboard and Public Transportation campaign reached 214,930 individuals.
4. Education packet distribution- COVID - 372 educational packets were distributed.
5. Website content - COVID - Three recipe videos, four Book Bites recordings, and three content videos were created and received 3,085 views on YouTube and Facebook. Book Bites ZOOM Classes had 49 participants for the Book Bites series delivered via ZOOM/FB.

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

The broader public benefits from the advancement of these objectives in the following manner:
• Improvement in individual health can improve public health status, i.e., stronger immunity, disease resistance, reduced transmission of disease
• Improvement in health can result in reduce healthcare cost for employers related to healthcare, workers compensation, absenteeism, and correlate into improved productivity

Closing Out (end date 09/06/2023)

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

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

The central questions 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 April 2021 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 2019 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" has been presented at the 2022 Urban Affairs Association Conference, Washington, DC, April 12-15, 2022.

Food marketing in Alabama and the Southeast

Project Director

Joel Cuffey

Organization

Auburn University

Accession Number

1023614

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

Alabama and other Southeastern states suffer from high rates of obesity and diet-related illnesses. Individual preferences, government policies, and access to stores may contribute to unique diets in the Southeast. This research project seeks to discover the reasons that consumers choose a particular food, or choose to visit a specific food store. In addition, this project will investigate the roles of government policies such as food assistance programs in influencing consumer food and food store
choices.

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 will benefit consumers in Alabama and the Southeast who are at higher risk for illnesses such as diabetes. The project will also benefit Alabama producers and agribusiness by highlighting strategies to market foods to consumers in the
Southeast.

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

Target audiences included: graduate students (1 Ph.D.), undergraduate students in two courses (Agricultural Prices and Futures & Options), Alabama food consumers, Alabama farmers, organic farmers, organic retailers, Southeast food bank and food pantry administrators, Alabama state government.

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

Major goals of the project:

Goals: This project seeks to discover the reasons that consumers choose a particular food, or choose to visit a specific food store. In addition, this project will investigate the roles of government policies such as food assistance programs in influencing consumer food and food store choices.

Objective 1. Study consumer preferences for food in Alabama, the Southeast, and the U.S.
This research objective will seek to understand what factors influence consumer preferences for specific foods and food in general. Factors will include internal factors such as affect, time, and risk preferences, as well as external factors such as price, quality and convenience. This objective will serve two purposes. It will first uncover ways to improve the diet and wellbeing
of consumers in Alabama. Second, it will provide direction to Alabama farmers regarding ways to market produce more effectively.

Objective 2. Investigate the role that government policies play in consumer food choice
One significant external factor influencing consumer food choice is government actions. The state and federal governments manage overlapping programs designed to influence consumer demand for food. Examples include the Supplemental Nutrition Assistance Program (SNAP), the Special Supplemental Nutrition Program for Women, Infants, and Children, and the National School Lunch Program. Each program seeks to increase demand for food, but does so in different ways and each has separate implications for consumer diets as well as farmer marketing. This research objective will study how consumers interact with these government policies, what impact these interactions have on consumer behavior, and how the policies further influence broader society including rural communities. The research serves the needs of Alabama consumers by understanding their use of government programs and will also inform Alabama farmers on issues directly related to marketing agricultural products.

Objective 3. Study reasons that consumers visit different food stores
Consumers purchase specific foods once at a store, but first decide where to buy food. This initial decision can influence the range (and quality) of foods that consumers are exposed to. In addition, this initial decision determines the economic viability of grocery stores especially in rural areas. This research goal will seek to understand this initial decision process. For example, how much does distance influence the decision to go to one store versus another? How does this decision change throughout time for the consumer and also for any particular store? How do stores use information about their customers to choose different promotion, pricing, or product strategies? The proximate result of this research objective will be to improve

the viability of rural (mainly independent) grocers throughout Alabama and the Southeast. Understanding consumer choice of
store will also provide insight into ways to improve diets in the Southeast. Finally, understanding grocery store strategy will help Alabama farmers by opening another potential market for Alabama products.

What was accomplished under these goals?
Objective 1: Study consumer preferences for food in Alabama, the Southeast, and the U.S.
We published an interdisciplinary paper linking parasitic infection with health and food choices in the U.S. In addition, we continue to analyze data on willingness to pay for organic food among Alabama consumers. This information is being prepared for publication in an academic journal. Finally, we have obtained access to restricted data through the National Center for Health Statistics. These data will form the basis for a number of future projects.

Objective 2: Investigate the role that government policies play in consumer food choice
We published one paper on SNAP work requirements and are preparing another paper on SNAP work requirements for submission.

Objective 3: Study reasons that consumers visit different food stores
We published one paper on retail food store format choice of consumers. We are preparing two other papers on store format choice as well as one other paper on the link between store access and food waste.

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 PhD student was trained on GIS methods and advanced program evaluation techniques.

The results from this project have been presented in academic department seminars and are being submitted to journals that have widespread readership. In addition, results have been presented to Alabama food policy stakeholders.

In the next reporting period, we will aim to:
- Submit two papers using the Alabama organics survey data. These will inform Alabama business leaders and local governments to develop policy.
- Finalize one PhD student thesis
As we complete some of these projects we will aim to start work on other projects, most especially the project requiring restricted access data. These data will form the basis for new projects in the next reporting period.

Journal Articles Published 2021
Cuffey, Joel, Timothy K.M. Beatty, and Elton Mykerezi. 2021 Work Effort and Work Requirements for Food Assistance among U.S. Adults.
American Journal of Agricultural Economics.

Cuffey, Joel, Timothy K.M. Beatty. 2021. Effects of competing food desert policies on store format choice among SNAP participants. American Journal of Agricultural Economics.

Cuffey, Joel, Christopher A. Lepczyk, Shuoli Zhao, and Nicholas Fountain-Jones. Cross-sectional association of Toxoplasma gondii exposure with BMI and diet in US adults. PLOS Neglected Tropical Diseases

Survey Instruments
Designed survey instrument to measure access to food in rural Alabama.

Relationship-based Research, Outreach, and Education in Couples with Chronic Illnesses

Project Director
Joshua Novak
Organization
Auburn University
Accession Number
1023159

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

Among all aims in this proposed Hatch Project, it seeks to (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.

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 will both collect longitudinal bio-, psycho-, physio-, and sociological data of multiple family members in both real world and intervention conditions and distribute resources and education to families with chronic illnesses and professionals who have a vested interest. Taken together, this project aims to decrease healthcare utilization for families (because intervention will target multiple family members at the same time) which
will ultimately reduce taxpayer burden so that resources can be saved, pooled, or better appropriated.

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

The target audience reached during this reporting period included the readership of academic journals, including Annals of Behavioral Medicine and several other outlets (with manuscripts under review).

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

The work of this Hatch project has two primary goals: Goal 1 will produce basic research on couple dynamics in those with chronic illnesses. Aim 1a seeks understand health congruence and health behavior concordance between partners in order to identify similarities, differences, and reciprocal influences so that the timing and approach of couple-focused intervention efforts can be improved. Aim 1b seeks to Identify key individual, relational, and contextual factors that moderate the nature of partner involvement in the physical and psychological adjustment of the patient with a chronic illness. This aim will help illuminate important ecological considerations that can improve the tailoring of intervention strategies. Aim 1c seeks to examine the non-ill partner's risk of disease and illness in order to focus so that programs can target outcomes for both partners and identify where resources can be saved, pooled, or better appropriated to interventions that target multiple family
members at the same time. Goal 2 will produce translational and applied research in couples with chronic illnesses. Aim 2a seeks to establish an online library of couples with chronic illness literature and scholarly work (from already published and emerging research) in collaboration with librarians, information technology (IT) specialists, and software engineers so that families, researchers, and the general public can access the latest information on how couples experience, cope with, and manage illness. Finally, Aim 2b seeks to test the impact of relationship-focused prevention and intervention programs such as relationship education programs and health-behavior specific programs (nutrition, sleep, and exercise) on physical, emotional,
and relational health to improve the lives of couples with chronic illnesses. This aim seeks to provide systemic education and intervention to couples regardless of physical location (e.g., rurality) in order to improve the physical health and relationship functioning of both partners.

Accomplishments under these goals:
Goal 1 was both accomplished and is still ongoing. Several publications have been accepted, submitted, or in development.
Goal 2 was not accomplished, but several related grants were pursued (but not funded).

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 above goals and aims have brought together professionals, faculty, and students from several disciplines and programs across the university (including a new working relationship with professionals in pharmacy (aim 2a)). Additionally, this Hatch project has spurred participation in the Telehealth Network (state-level, collaborative group consisting of faculty and scholars from UAB, Auburn, UA, and ACES) and within that network, the Diabetes and Obesity subgroup. These networks and groups have focused on building relationships, and sharing resources (grant opportunities, etc.

Results from the project have been disseminated to several national conferences, including Gerontological Society for America, National Council for Family Relations. There were also several regional presentations:

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.

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.

Wei, M., Novak, J.R., Miyairi-Steel, M., Peak, T., & Gast, J. Health Support, Health Control, and Intuitive Eating in Gay Married Men. Poster presented at the National Conference for Family Relations. November, 2020. St. Louis, MO.

Novak, J. R. Helping, Hurting, or Both?: Exploring Typologies of Type 2 Diabetes Family Members' Distress and Involvement. Poster presented at the 13th Annual Boshell Research Day. Boshell Diabetes Group. September, 2021. Auburn, Alabama.
Wood, M., Bostany, E. , & Novak, J. R. Covid-19 Pandemic and Family Systems. Poster presented at the Auburn Research Student Symposium. March, 2021.

Seaton, K. M., & Novak, J. R. Parenting Behaviors, Child Physical Activity, and Screen-Time Among Families with ADHD. Poster presented at the Auburn Research Student Symposium. March, 2021.

Ryan, K., Thomas, A., Ellis, F., & Novak, J. R. By Chance, with Confidence, or Both?: Testing Important Moderators Between Partner Diet Undermining and Poor Diet in Heterosexual Couples. Poster presented at the Auburn Research Student Symposium. March, 2021.

Novak, J. R., Robinson, L., Burke, L., Wei, M., & Adler-Baeder, F. Results from a Pilot Program for Couples with Chronic Illnesses during the COVID-19 Pandemic. Poster presented at the 2021 Faculty Research Symposium at Auburn University, Auburn, Alabama. January, 2021.

Plans for next reporting period to accomplish the goals:
Aim 1a-1c: Finish Data collection and begin analyses
Aim2a: Finish manuscripts and begin new manuscripts
Aim2b: Pursue Internal and external funding opportunities

Journal Articles Accepted 2021
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 (40% contribution; ISI impact factor = 4.908; 2020). http://dx.doi.org/10.1093/abm/kaab099

Journal Articles Under Review 2021
Novak, J. R., Wilson, S. J., Ermer, A. E., & Harper, J. M. Aging Together: Dyadic Profiles of Older Couples’ Marital Quality, Psychological Well-being, and Physical Health. The Journals of Gerontology: Psychological Sciences

Novak, J. R., Pratt, K., Hernandez, D. C., & Berge, J. M. Family Systems and Obesity: A review of key concepts and influences within and between family subsystems and a Call for Family-Informed Interventions.

August, K., Novak, J. R., Peak, T, Gast, J., & Miyairi, M. Examining Foodwork and Eating Behaviors Between and Among Heterosexual and Gay Couples

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. Health Psychology

Changes/Problems
The COVID-19 pandemic has continued to interfere with research activities, however, switching strategies to online data collection has been fruitful.

The Association of Food Deserts and the Prevalence of Obesity in North Alabama

Project Director
Ebony Weems
Organization
Alabama A&M University
Accession Number
1021011

Functional Analysis

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

This research project evaluates the impact of food deserts on the prevalence of obesity. The project will also shed light on future studies identifying the role of microbial metabolites in adipogenesis and the onset of obesity and other metabolic diseases such as insulin resistance in adults.

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

Objective #1 - Geographic Information System (GIS) analysis was used to analyze the food access zones in five major counties in Alabama. Results demonstrated a direct relationship between increased incidence of obesity and metabolic syndrome and access to grocery stores. The possible relationship between access to transportation and the prevalence of metabolic disorders was also studied. The data suggest a direct correlation between these two variables.

Objective #3 - A functional gene analysis was done to study the genes associated with glucose uptake in the intestinal epithelial layer. gene set enrichment analysis was performed to identify six candidate genes. Two of the six genes were found associated with biological pathways that are differentiated in epithelial cells in a high-glucose environment.

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

Results from objective #1 will be published and the information will be used as a framework to inform outreach programming and a health/food drive.

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

Results obtained from this project will be used to contribute to solutions in the reduction of food deserts across North Alabama. These results will also lead to future studies identifying the role of microbial metabolites in adipogenesis and the onset of obesity in adults and adolescents. More importantly, the objectives the objectives proposed in this project will provide students with training
opportunities in integrative and innovative research.

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 largely unexamined. 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 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.

Addressing these knowledge gaps, this study will use recently released longitudinal, cohort sequential, and repeated cross-sectional data from two large national studies to examine recent historical changes (secular trends) in the strength of the association between childhood SES and adult health. Previously unexamined mechanisms for changes over time, vis-à-vis rising income inequality, changing occupational characteristics, and the shifting role of adult psychosocial mediators (e.g., workplace experiences, discrimination) will also be examined by merging data from additional databases and capitalizing on rich person-level assessments. The proposed study is novel in that it will be among the first to elucidate changes
in the strength of the association between childhood SES and adult health in the United States, and the to systematically examine reasons for these changes. To address this topic, the study brings together rich national data from four complementary sources. By generating knowledge of mechanisms for secular trends in the association between childhood disadvantage and adult health, this study seeks to provide insight into policy solutions to reduce social stratification of health outcomes.

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

The scientific knowledge generated from this project will be relevant to academic, policy, and practitioner audiences.

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

The proposed study will use longitudinal, cohort sequential, and repeated cross-sectional data from two large national studies
of health and aging to examine recent historical changes (secular trends) in the strength of the association between childhood SES and adult health. Objective measures of state-level income inequality and occupation-level job characteristics will also be employed by merging measures from two additional national databases into person-level data files. The specific aims of the proposed project are as follows:

Aim 1: Examine the magnitude of the secular trend in the association between childhood disadvantage and adult health using two data sources. Preliminary analyses provide evidence of a secular trend in one data source using a repeated crosssectional study design. Proposed analyses for Aim 1 will replicate preliminary findings in a second national data source and extend them using longitudinal and cohort sequential data. Aim 1 will also examine variability in the magnitude of the secular trend across health outcomes and measures of childhood socioeconomic disadvantage.

Aim 2: Explicate the changing role of adult status mediators in the association between childhood disadvantage and adult health. More specifically, analyses for this aim will consider whether mediating mechanisms for the effects of childhood disadvantage on adult health through three adult status mediators (educational attainment, household income, and occupational characteristics) might have changed over time and the degree to which these changes might account for changes in the strength of childhood disadvantage on adult health.

Aim 3: Consider the role of state level income inequality as a moderator of the association between childhood disadvantage and adult health and an explanation for the hypothesized secular trend. Income inequality data will be considered as time varying and examined using and lagged approach from year of data collection as well as a life span exposure approach with consideration of specific developmental periods.

The published findings from our research are based on a study of 263 young adult college students and focus on the role of neighborhood environments in sleep health disparities. Neighborhoods have become more segregated by socioeconomic disadvantage in recent decades and thus the role of neighborhoods in various domains of disparities are an increasingly

important consideration. The sample for our study was recruited to be approximately half Black/African American and half White/European American. Sleep parameters were assessed from eight nights of wrist actigraphy (time in bed, sleep duration, and efficiency) and an established self-report measure of daytime sleepiness. Residential histories from birth through age 18 were documented, and retrospective self-reports of neighborhood safety in childhood were assessed. Findings support the hypothesis that neighborhood safety in childhood may partially account for race differences in subsequent sleep duration and daytime sleepiness. Addressing racial inequities in childhood neighborhood safety may be an important step toward reducing health disparities.

A second article published in this reporting period was a commentary on contemporary population health research challenges. With unprecedented increases, mortality trends in the United States have received significant attention in recent years. To date, research on this topic has emphasized specific causes of death and proximal behavioral or physiological determinants. In this commentary, I considered recent novel contributions examining trends in mental health, health behaviors, and physiological dysregulation. I then discussed broader developments in related research and made a case for 1) not allowing recent health trends among Whites to overshadow the urgent work that needs to be done to mitigate persistent
racial inequities, 2) further investigation of what accounts for increases in income inequality and its life-span health consequences, and 3) broadening the scope of mechanisms considered to include under-discussed topics such as the role of increases in social media use or environmental toxicant exposures. Underlying several potential explanations for observed trends in health and mortality is the fact that substantial change has occurred on multiple fronts in US society and that policy responses to these changes have been insufficient. An enhanced emphasis on innovative population health research will be essential to provide the evidence base needed for policymakers to rise to these urgent challenges.

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.

Journal Articles Published 2021

Fuller-Rowell, T. E., Nichols, O. I., Robinson, A. T., Boylan, J. M., Chae, D. H., & El-Sheikh, M. (2021). Racial disparities in sleep health between Black and White young adults: The role of neighborhood safety in childhood. Sleep Medicine, 81, 341-349. https://doi.org/10.1016/j.sleep.2021.03.007

Fuller-Rowell, T. E. (2021). Invited Commentary: Population Health in Peril: Needed US Science and Public Policy Action. American Journal of Epidemiology, 190, 2256–2259. https://doi.org/10.1093/aje/kwab162

Curtis, D. S., Fuller-Rowell, T. E., Carlson, D. L., Wen, M., & Kramer, M. R. (2021). Does a Rising Median Income Lift All Birth Weights? County Median Income Changes and Low Birth Weight Rates Among Births to Black and White Mothers. The Milbank Quarterly. https://doi.org/10.1111/1468-0009.12532

Fuller-Rowell, T. E., Nichols, O. I., Jokela, M., Kim, E. S., Yildirim, E. D., & Ryff, C. D. (2021). Repercussions of an Increasingly Divided Society: The Full Population Health Consequences of Increased Social Stratification are on the Horizon. American Journal of Epidemiology, 190, 2297-2299. https://doi.org/10.1093/aje/kwab169

El-Sheikh, M., Zeringue, M. M., Saini, E. K., Fuller-Rowell, T. E., & Yip, T. (2021). Discrimination and adjustment in adolescence: the moderating role of sleep. Sleep. https://doi.org/10.1093/sleep/zsab215

Developing A Sustainable Research Program In FoodOmics at Alabama A&M University Project Director

JU DITH BOATENG
Organization
Alabama A&M University
Accession Number
7002677

Developing A Sustainable Research Program In FoodOmics at Alabama A&M University

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

The goal of this proposal is to establish and maintain a sustainable research laboratory in which graduate students within the FS graduate program can receive a broad research experience and training in Foodomics. Foodomics is a new field that is helping to define food science from a broader point of view through, molecular biology, analytical chemistry, and biochemistry. All these methods are driven by the need to provide solutions to the demands of consumers, producers, food industry, regulatory agencies and consumers in order to advance food quality, functionality to improving 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.

Major activities achieved:

Completed objective 2 of the project: The protective properties of basil and ginger against non-alcoholic fatty liver disease (NAFLD) using Foodomics Techniques. Data is currently being analyzed. Completed feeding studies to determine the anti-obesity and hepatoprotective effects of mixed fruits and berries (MFB) on cafeteria-style (western) diet-induced obesity and non-alcoholic fatty liver disease in rat model. Initial results show that MFB reduced body weight and BMI (g/cm2). Adipose tissue and liver mass were significantly reduced in MFB fed groups, and histopathological analysis of liver showed reduced hepatic steatosis in MFB groups when compared to CAF only group. Secondary data to determine impact of MFB on gut microbiota characterization, biochemical serum markers, and inflammatory cytokines is currently underway.

This grant supported a study to determine the ability of Lactic acid bacteria in mitigating the spoilage of dairy products caused by two psychrotolerant bacteria. This work studied the ability of two lactic acid bacteria (Streptococcus thermophilus STB01and Lactobacillus rhamnosus LGG) in mitigating the proliferation of Psychrotolerant (P. fluorescens W5-203 and B. licheniformis H7-968) and selected antimicrobial-resistant bacteria in cheeses. The study also investigated the occurrence and rate transfer of antimicrobial-resistant genes in lactic acid bacteria. Overall the study indicated that lactic acid bacteria could be used to mitigate spoilage and antimicrobial- resistant in foods. This year we recruited one underrepresented graduate student.?

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

This grant supported and provided experiential learning opportunities, research training and mentorship to underrepresented graduates and undergraduate students in foodomics research. In 2021, the grant provided support for two graduate students (PhD) with experiential research training and mentorship to complete dissertation research. One student (Dr. Deborah Abraham Bethe) is employed as postdoctoral researcher and the other student (Dr. Ahmed Gomaa) is employed in the Food Industry.

Two newly recruited graduate students are being trained and gaining experience in foodomics research.

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

The results from this project has been widely disseminated to stake holders and broader public through presentations at conferences and in journal articles. Two PhD dissertations and one manuscript have been published. Three manuscripts are currently under preparation for publication.

Publication:

Gomaa, A., S. Willis, M. Verghese and J. Boateng, 2021. Probiotic Fermentation of Konjac and Carob Pods Ceratonia siliqua and Observation of Related Antioxidant Activity. Am. J. Food Technol., 16: 18-30

A Study of the Antimicrobial & Selected Health Promotive Effects of Synbiotics. Gomaa, Ahmed. Alabama Agricultural and Mechanical University, ProQuest Dissertations Publishing, 2021. 28543777.

Biopreservation: A Tentative and Alternative Approach in Mitigating Food Loss and Antimicrobial Resistant Microorganisms in Fermented Foods. Abraham-Bethel, Deborah Flavy. Alabama Agricultural and Mechanical University, ProQuest Dissertations Publishing, 2021. 28652158.

Closing Out (end date 09/06/2023)

Promoting Relational Health Among Limited Resource Parents

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.

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.

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 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 + parenting skills training; CRE + stress management/mindfulness training).

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

In order to meet the current needs around healthy marriage and stable families in Alabama communities for this reporting period (October 1, 2020, to September 30, 2021) we served:

High school youth:
• We reached 101% of our enrollment target for youth (950 enrolled/700 target). Of the 950 youth enrolled during this reporting period, 161 youth enrolled during the month of September 2021 and will complete program participation during the following reporting period (October 1, 2021 - September 30, 2022). We implemented 53 workshop session series during this project year with an average of 16-17 youth in each session.
• Our youth averaged 10 primary workshops hours.84% (440/525 target for PY1) of our youth attended 100% or more of primary workshop hours and 139% (777/560 target for PY1) attended 50% or more of primary workshop hours.

Low-resource couples
• We reached 103% of our enrollment target for adult couples (294 enrolled/285 target). We offered 29 workshop session series, with an average of 10 adult couples participating in each session.
• We also reached 102% of our completion target for adult couples (229 completed/225 target). Completion was defined as attending all sessions provided for the 6-session series.
• Our adult couples averaged 11 primary workshop hours. 79% of our adult couples attended 100% or more of primary workshop hours and 86% attended 50% or more of primary workshop hours.
Overall, program participation is high. We are pleased to report that 86% of adult couples and 139% of youth target for PY1 attended 50% or more of a program.

The generated summary of adult couples' applicant characteristics revealed that we served a racially diverse (56% Black or African-American; 41% White; 3% other races) and primarily low-income population (48% 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 (38% White; 51% Black or African-American; 3% Latinx, 1% Asian American, 1% American Indian/Alaskan Native, and 5% other/mixed ethnicity [1% did not report ethnicity]). Further, 58.5% of youth identified as female, 39.5% as male, and 2% as non-binary or transgender.

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

Major goals of the project:
1) Investigate the effectiveness of community-based couples/relationship education (CRE) programs for limited resource parents on measures of individual well-being, couple functioning, coparenting functioning, parenting, and child outcomes.
2) Investigate moderators of change patterns (i.e., participant and program characteristics) that explain variation in outcomes.
3) Investigate the comparative benefits of alternate forms of the program in which program content varies (i.e., CRE only; CRE + parenting skills training; CRE + stress management/mindfulness training).

Initial publications from the efficacy study results are emerging. These emphasize the 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 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 decline (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. A separate publication is in process on these test results. We also have evidence that different profiles of participants experienced differential patterns of change over the 2 year period, using mixture modeling procedures. A publication on these results is also in process.
Using path analyses, results also supported the hypothesis related to spillover of improved couple skills post-program to 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 ($\beta = .205$, $p < .001$).

These results were included in a proposal for another 5-year cycle of funding from the U.S. Dept of Health and Human Services for expansion of a process evaluation and notice of award was received at the end of September 2020. We also proposed an efficacy study of youth relationship education, comparing outcomes for youth with community educators vs. near-peer (trained undergraduate students) as facilitators. Both projects were funded. The total funding award for 2020-2025 from the Office of Family Assistance is $12.5 million.
2021 was the start-up period for the two new efficacy studies and goals centered on piloting methods of recruitment and data collection. Major accomplishments include:

1. Meeting the target numbers of couples enrolled and completed in the program; 294 couples enrolled; 229 couples completed programs; 950 youth enrolled; 619 youth completed programs
2. 252 couples and 35 individuals in a couple relationship completed baseline surveys; 114 couples and 29 individuals in a couple relationship completed post-program surveys; 92 couples and 29 individuals in a couple relationship completed 6-month follow-up; NOTE: not all participants were eligible for post-program or 6-month follow-up surveys at the time of this report.
3. 436 youth completed baseline data; 406 youth completed post-program surveys.

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.

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 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. The final report for the efficacy trial was reviewed by the funder and accepted in early 2021. This report is publicly available. Dissemination of results was also shared through conference presentations. Additionally, a final stakeholder report reviewing the activities of the entire project, as well as program outcomes and impacts was completed in 2021. This is accompanied by an executive summary and an infographic detailing outreach over the past 18 years:

Adler-Baeder, F., McGill, J., Jackel, R., et al., (2021). Promoting Relational Health in Alabama. (public report). https://www.alabamamarriage.org/assets/uploads/2021/02/AL_HealthyMarriage-Glossy-Report.pdf
Adler-Baeder, F., McGill, J., Jackel, R., et al., (2021). Promoting Relational Health in Alabama: Executive Summary. https://www.alabamamarriage.org/assets/uploads/2021/02/AL_HealthyMarriage-ExecutiveSummary.pdf
Adler-Baeder, F., McGill, J., Jackel, R., et al., (2021). The Alabama Healthy Marriage and Relationship Education Initiative: By the Numbers 2002-2020. https://www.alabamamarriage.org/assets/uploads/2021/02/AHMI_2002-2020-Infographic.pdf

We will continue to prepare and submit manuscripts from the completed efficacy study and will launch the 2 new efficacy studies of couples education and youth relationship education. 4-time points of data collection are planned for couples over 1 year; 3-time points of data collection are planned for youth.

Journal Articles Published 2021
Adler-Baeder, F., Futris, T., McGill, J., Richardson, E., & Dede Yildirim, E. (2021). Development and validation of the Couple Relationship Skills Inventory. Family Relations. https://doi.org/10.1111/fare.12590

McGill, J., Adler-Baeder, F., & Garneau-Rosner, C. (2021). An evaluation of ELEVATE: Taking Your Relationship to the Next Level. Family Relations, 70(1), 327-351.

Cooper, E.*, Adler-Baeder, F., & McGill, J. (2021). Individual mental health and couple functioning: Exploring changes among couple relationship education participant outcomes. Journal of Marital and Family Therapy. 47(4), 945-961.

Fuller-Rowell, T., Nichols, O., Doan, S., 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 DOI: 10.1177/21676968211042111.

Journal Articles Awaiting Publication 2021
Adler-Baeder, F. McGill, J., Yildirim, E.D., Gregson, K., Cooper, E., Burke, L., Finnegan, V., & Jackel, R. (in press). Simultaneous Randomized Control Trials of the One-Year Efficacy of Two Couple Relationship Education Programs: ELEVATE and Couples Connecting Mindfully. Family Process.

Chan, A., Harcourt-Medina, K.T., & Adler-Baeder, F. (in press) Classroom gender composition in the context of youth relationship education. Family Relations.

Jackson, T.*, Adler-Baeder, F., Burke, L., & Vilches, S. (in press). Evaluating a relationship education program with incarcerated adults. Journal of Human Sciences and Extension.

Books Awaiting Publication 2021
Adler-Baeder, F. & Gregson, K. (in press). 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. (in press). Stepfamily education. In Hartenstein, J. L. (Ed). Marriage and Divorce in America. Santa Barbara, CA: ABC-CLIO.

Other Published 2021
Adler-Baeder, F., McGill, J., Gregson, K. (2021). Impact Evaluation of ELEVATE and Couples Connecting Mindfully in Alabama: Final Impact Evaluation Report for Auburn University. Administration for Children and Families, US Dept. of Health and Human Services. Techical Report.

Adler-Baeder, F., McGill, J., Jackel, R., et al., (2021). Promoting Relational Health in Alabama. (public report). https://www.alabamamarriage.org/assets/uploads/2021/02/AL_HealthyMarriage-Glossy-Report.pdf

Adler-Baeder, F., McGill, J., Jackel, R., et al., (2021). Promoting Relational Health in Alabama: Executive Summary. https://www.alabamamarriage.org/assets/uploads/2021/02/AL_HealthyMarriage-ExecutiveSummary.pdf
Adler-Baeder, F., McGill, J., Jackel, R., et al., (2021). The Alabama Healthy Marriage and Relationship Education Initiative: By the Numbers 2002-2020. https://www.alabamamarriage.org/assets/uploads/2021/02/AHMI_2002-2020-Infographic.pdf

Data and Research Material
Journal Articles:
Adler-Baeder, F. McGill, J., Yildirim, E.D., Gregson, K., Cooper, E., Burke, L., Finnegan, V., & Jackel, R. (in press). Simultaneous Randomized Control Trials of the One-Year Efficacy of Two Couple Relationship Education Programs: ELEVATE and Couples Connecting Mindfully. Family Process.

Adler-Baeder, F., Futris, T., McGill, J., Richardson, E., & Dede Yildirim, E. (2021). Development and validation of the Couple Relationship Skills Inventory. Family Relations. https://doi.org/10.1111/fare.12590

McGill, J., Adler-Baeder, F., & Garneau-Rosner, C. (2021). An evaluation of ELEVATE: Taking Your Relationship to the Next Level. Family Relations, 70(1), 327-351.

Cooper, E.*, Adler-Baeder, F., & McGill, J. (2021). Individual mental health and couple functioning: Exploring changes among couple relationship education participant outcomes. Journal of Marital and Family Therapy. 47(4), 945-961.

Chan, A., Harcourt-Medina, K.T., & Adler-Baeder, F. (in press) Classroom gender composition in the context of youth relationship education. Family Relations.

Jackson, T.*, Adler-Baeder, F., Burke, L., & Vilches, S. (in press). Evaluating a relationship education program with incarcerated adults. Journal of Human Sciences and Extension.

Fuller-Rowell, T., Nichols, O., Doan, S., 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 DOI: 10.1177/21676968211042111.

Technical Reports:
Adler-Baeder, F., McGill, J., Gregson, K. (2021). Impact Evaluation of ELEVATE and Couples Connecting Mindfully in Alabama: Final Impact Evaluation Report for Auburn University. Administration for Children and Families, US Dept. of Health and Human Services. Techical Report.

Adler-Baeder, F., McGill, J., Jackel, R., et al., (2021). Promoting Relational Health in Alabama. (public report). https://www.alabamamarriage.org/assets/uploads/2021/02/AL_HealthyMarriage-Glossy-Report.pdf

Adler-Baeder, F., McGill, J., Jackel, R., et al., (2021). Promoting Relational Health in Alabama: Executive Summary. https://www.alabamamarriage.org/assets/uploads/2021/02/AL_HealthyMarriage-ExecutiveSummary.pdf

Adler-Baeder, F., McGill, J., Jackel, R., et al., (2021). The Alabama Healthy Marriage and Relationship Education Initiative: By the Numbers 2002-2020. https://www.alabamamarriage.org/assets/uploads/2021/02/AHMI_2002-2020-Infographic.pdf

Book chapters:
Adler-Baeder, F. & Gregson, K. (in press). 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. (in press). Stepfamily education. In Hartenstein, J. L. (Ed). Marriage and Divorce in America. Santa Barbara, CA: ABC-CLIO.

Closing Out (end date 09/06/2023)

Childhood Obesity in Alabama: Risk Factors

Project Director
Geetha Thangiah
Organization
Auburn University
Accession Number

Childhood Obesity in Alabama: Risk Factors

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

Childhood obesity is a major public health concern in the United States. Obese children are at higher risk to develop type 2 diabetes, cardiovascular disease, cancer, sleep apnea and a greater risk of social and psychological problems. In the United States, approximately 12.7 million children and adolescents are classified as obese (1).The prevalence of obesity is 8.9% among 2 to 5 year-olds compared with 17.5% of 6 to 11 year-olds and 20.5% of 12 to 19 year-olds (2). Around $190 billion dollars have been estimated as annual medical expenditures associated with 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.

The long-term goal is to improve the health of children specifically in Alabama by identifying the multiple factors, such as biological, genetic, lifestyle, socioeconomic, dietary habits, and parental influences that could lead to childhood obesity. This will
help to identify appropriate interventions to reduce childhood obesity and related health outcomes in minority children.
The overarching hypothesis of this proposal is that identification of multiple factors that could lead to childhood obesity, such as
behavioral, lifestyle, socioeconomic, dietary habits, parental influences, genetic, and biological factors, will help in the development and implementation of innovative tailored solutions to reduce obesity.

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.

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

The overall goal of this proposed study is to evaluate the multiple factors such as environmental, lifestyle, economic, parental influences, biological, genetic, oral, and gut microbiomes that could lead to childhood obesity.
Objective 1: Determine the relationship of the behavioral factors associated with childhood obesity.
Findings:
We determined the association between maternal education and eating behavior in children. The increased food responsiveness and emotional overeating in obese children are influenced by maternal education.
Objective 2: Determine the genetic factors associated with childhood obesity.
Findings:
We explored the connection between telomere length ratio, blood pressure, and childhood obesity. The overweight/obese children have higher systolic pressure compared to normal-weight children. African American children have a greater mean telomere length ratio and blood pressure compared to European American children.
Objective 3: Determine the salivary and gut microbiome in childhood obesity.
Findings:
We attempted to generate a profile of gut and oral microbial clades predictive of disease status in African American and European American children. Gut and oral microbial diversity between African American and European American children showed significant differences in alpha-, beta-, and taxa-level diversity. Socioeconomic factors influenced microbiota in obesity, and it was ethnicity-dependent.

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.

Dr. Geetha Thangiah (PI) of this project contributed to the planning and execution. PI also contributed to the experimental design and analysis, manuscript preparation, and revision. The graduate students, undergraduate students, and postdoctoral fellows contributed to the laboratory experiments, analysis of the questionnaire, and statistical analysis. Most of them were also involved in the writing of the manuscript and presentation of the results in local and national meetings.

The findings from this research proposal were reached to the scientific communities through our publications and presentations in local and professional meetings. We are planning to investigate the genetic factors involved in childhood obesity, the genomic copy number variants in lean, overweight, and obese children.

Journal Articles Published 2021
Ayine P, Selvaraju V, Venkatapoorna CMK, Bao Y, Gaillard P, Geetha T. Eating behaviors in relation to child weight status and maternal education. Children 2021 Jan 7;8(1):32. doi: 10.3390/children8010032.

Selvaraju V, Phillips M, Fouty A, Babu JR, Geetha T. Telomere length as a biomarker for race-related health disparities. Genes 2021 Jan 9;12(1):78. doi: 10.3390/genes12010078.

Balakrishnan B, Selvaraju V, Chen J, Ayine P, Yang L, Babu JR, Geetha T, Taneja V. Ethnic variability associating gut and oral microbiome with obesity in children. Gut Microbes 2021 Jan-Dec;13(1):1-15. doi: 10.1080/19490976.2021.1882926.

Conference Papers and Other 2020
Selvaraju V, Babu JR, Geetha T. Telomere length as a biomarker for race-related health disparities. “Health Disparities Research Initiative”, Auburn University, Auburn, AL, USA, 2020.

Conference Papers and Other 2021
Ayine P, Selvaraju V, Venkatapoorna CMK, Bao Y, Gaillard P, Geetha T. The Children’s Eating Behaviors: Relation to child weight status and maternal education. “CHS Graduate Student Research Symposium”, Auburn University, Auburn, AL, USA, March 19, 2021.

Patel P, Selvaraju V, Geetha T. Epigenetics, diet, and obesity. “CHS Graduate Student Research Symposium”, Auburn University, Auburn, AL, USA, March 19, 2021.
NIFA Support Acknowledged

Conference Papers and Published 2021
Ayine P, Selvaraju V, Venkatapoorna CMK, Bao Y, Gaillard P, Geetha T. The children’s eating behaviors: Relation to child weight status and maternal education. “Auburn Research Student Symposium”, Auburn University, Auburn, AL, USA,

Chester B, Selvaraju V, Martin K, Geetha T. Evaluating the Relationship Between Obesity and the Efficacy of a Diabetes Self-Management Education and Support Coaching Structure for the Ongoing Management of Type 2 Diabetes in North Alabama. “Boshell Diabetes & Metabolic Diseases”, 13th Annual Research Day, Auburn University, Auburn, AL, USA,

Selvaraju V, Balakrishnan B, Chen J, Ayine P, Yang L, Babu JR, Taneja V, Geetha T. Ethnic-specific Association of Gut Microbiome with Childhood Obesity. “Boshell Diabetes & Metabolic Diseases”, 13th Annual Research Day, Auburn University, Auburn, AL, USA, September 17, 2021. Abstract # P32.

Patel P, Selvaraju V, Babu JR, Taneja V, Geetha T. Epigenetic Changes in NRF1 and FTO Gene Through MethyLight Assay Amongst Races in Children. “Boshell Diabetes & Metabolic Diseases”, 13th Annual Research Day, Auburn University, Auburn, AL, USA, September 17, 2021. Abstract # P20.

Closing Out (end date 09/06/2023)

Evaluation of Health Promoting Properties of Selected Spices and Plant Extracts Against Obesity Induced Diabetes

Project Director
Martha Verghese
Organization
Alabama A&M University
Accession Number
7002718

"Evaluation of Health Promoting Properties of Selected Spices and Plant Extracts Against Obesity Induced Diabetes"

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

For the #1 objective outlined above, a graduate student (Jabari Hinton) completed a component of research, focusing on the use of hemp, coconut, and almond powders/flours as functional ingredients which may provide added health benefits not previously provided to the food products that would normally be consumed with 100% all-purpose flour. In that portion of the study highest DPPH inhibition was observed in Hemp (91.18%), compared to Coconut (89.1%), Almond (64.01%), and All-purpose (25.36%) flours. DPPH inhibition in Hemp samples provides evidence of the antioxidant capacity of hemp food products. Results from the work suggested that the acceptability of alternative flours with antioxidant potential may lead to a successful food product. He won 1st place in the SEIFT graduate student poster competition in April of 2022 and his abstract was accepted to present at the ARD 2022 symposium.
In the product development component of the project, the product was developed, incorporating various spices and plant protein powders into their formulations. The product was developed and was evaluated for its possible antioxidant abilities and effect on carbohydrate and lipid metabolizing enzymes. The product, 'Camunas', is a puff pastry treat made with spices, and alternative protein powders. The finished prebaked and post-baked product was tested for their antioxidant potential.
The 2nd product developed was a functional snack biscotti made with Ashwagandha, barley grass powder, gluten-free all-purpose flour, and hemp protein powders. Control sample with Gluten-free all-purpose flour was the most preferred (60%), followed by Barley and Hemp (20%), a combination of (gluten-free flour, hemp, gluten-free flour, and flaxseed) had an acceptance rate of (10%). Since consumer acceptance is a key factor in successfully negotiating functional food market opportunities, adjustments are being made to formulations to achieve a more acceptable functional snack attribute. Hemp blisscotti may be utilized as an alternative to other conventional products in the market and for its nutrient-dense properties. The student working on this component (Maryam Shomope) is working on the project and will be finishing in Fall 2022. As a result of this research, 2 abstracts were submitted and accepted to present at the ARD symposium 2022.
A doctoral student is working on objective #3 and the research outlined for this project is evaluating the effects of processing on the antioxidant potential/ phytochemicals of Murraya koenigii (curry leaf) and the possible mechanisms evaluating their effectiveness in the prevention of cardiovascular diseases, as a potent antioxidant. The student has started the preliminary work on drying the leaves in the oven at three selected temperatures and determining the temperature
that may be a viable option for enhancing shelf-life without loss of the health benefits. The other portions of the project are scheduled to begin in Summer 2022 which will encompass doing in-vitro and in-vivo studies using biological models. The study will delve into the possible mechanisms leading to the protective effects of Murraya Koenigii leaves to prevent Cardiovascular diseases.
The #4 objective is focused on the selected health benefits of Beta vulgaris and is carried out by a master's student (Terica Curtis). This objective has different parts, first was to promote the retention of phytochemicals, present in beetroot and foliage after the application of differing thermal processing methods. There is limited information on the effects of thermal processing on either the beetroot or foliage. The bioactive compounds present in beets have, however, shown to be beneficial for overall health. Food waste can pose an environmental and economic concern for the food industry, so the utilization of beet foliage (a usual waste product) can be effective in reducing waste for beet foliage. The other part of this objective involves the effect of beetroot and beet foliage on the metabolizing enzymes and evaluating the health benefits using cell culture models. Both Karthik and Terica started their work in Spring 2022 and have presented part of their research at STEM Day conference.

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 primary goal of the project is to study the potential health benefits of spices and plant protein extracts in consumable quantities and their mechanisms of action. Hence, the project outcomes will provide experiential training to students, data for competitive grants, aid in building collaborations, and improve the health and wellness of consumers at risk or health-conscious.

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

The development and consumption of functional foods may help reduce the risk of chronic diseases such as diabetes, CVD, obesity etc.

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

Help in the reduction of chronic diseases and reduction in health care 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.

N/A

Critical Issue

Natural Resource and Environmental Sustainability

Genetic determinants of fitness: interactions with the environment, effects on endangered species recovery, and long-term monitoring of wild populations

Project Director
Janna Willoughby
Organization
Auburn University
Accession Number
1025651

Genetic determinants of fitness: interactions with the environment, effects on endangered species recovery, and long-term monitoring of wild populations

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

Understanding and managing biodiversity, which comprises all of the plants, animals, microbes, and other species in an area, is
a critical aspect of ensuring our ecosystems function into the future. Typically, wild populations are considered stable, and biodiversity is conserved, when population size does not change from year to year. However, we do not completely understand
the forces that influence population size changes. For example, we know that individuals that have low levels of genetic diversity will sometimes have fewer offspring (reduced fitness) than those with more genetic diversity, but sometimes environmental effects (e.g. lots of rainfall) also changes individual's fitness.

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

My 5-year research plan includes several projects aimed at understanding how and when population fitness changes, what that means for endangered species, and how we can monitor these changes in large populations in the wild. These projects will leverage a combination of field work, whole genome resequencing, remote sensing, and modeling.

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

Nothing to report.

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

Major goals of the project:

Understanding patterns of biological diversity lies at the center of ecology and evolutionary biology. Typically, ecology has focused on the ways biological diversity has been maintained in various ecosystems whereas evolution has focused on the generation of biological diversity via changes in genetic diversity (Post and Palkovacs 2009). However, identifying the mechanisms by which ecology and evolution interact would reveal the drivers of individual differences in fitness, and understanding these mechanisms will allow us to make more robust predictions concerning how populations will react to changing environments. This development of fundamental knowledge- how populations interact and evolve on the landscapehas
direct implications for the monitoring and management of species of conservation concern as well as those that are managed for recreational purposes. In this 5-year plan, I will outline my research goals for: 1) defining the mechanistic genetic

and environmental underpinnings of individual fitness; 2) quantifying the magnitude of genetic determinants of fitness in an endangered species; and 3) developing necessary methodology for monitoring these determinants in animal populations at a landscape scale.

What was accomplished under these goals?
We have made substantial progress towards defining the relationship between environment, genetic variation, and fitness. We
have completed and published a reference genome assembly for our model species. We have also collected the genome sequencing data required to meet this goal and conducted preliminary analyses of these data. Based on this preliminary output, we have elected to enhance this first dataset with additional sequencing data. We have selected samples and prepared these for sequencing and are now awaiting data from the sequencing facility.

We have also made substantial progress on developing our understanding of how and when to deploy various monitoring methods to track wildlife population size. We have completed and published a meta-analysis comparing existing methodologies to understand, quantitatively, how methods differ in their sensitivity across taxa and ecosystems. We have also
constructed the backbone of an agent-based model that we will now parameterize to make more detailed comparisons across methodologies. Finally, we have completed sequencing of a large, three-year monitoring endeavor and have analyzed these genome sequencing data. We are awaiting sequencing data for year 2 samples to conduct a genetic mark-capture-recapture analysis. These data will ultimately help parameterize our model to make broad conclusions about how we can most efficiently track population size in large, wild populations.

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.

These projects have provided research-based training to 2 graduate students and 1 postdoc over the last year. In addition, I taught a graduate-level course focused on developing agency-based models to 8 graduate students and assisted 2 others in developing their own models. Next year, I will expand my graduate course offerings to provide conservation and geneticsfocused
content to graduate students across campus.

Our results have been published in 3 peer-reviewed papers. In addition, trainees (graduate student and postdoc) and I have presented at the American Genetic Association Conservation Genomics conference (2 presentations) and at International Conference on Conservation Biology (4 presentations). As the projects progress, we will work on the extension and outreach components of each objective.

We plan to complete our analysis linking genome variation, environmental change, and fitness to each other in our model species. We will also collect the epigenome data for this project.
We will complete a genetic mark-capture-recapture analysis for a very large monitoring project and then use these results to refine and complete our agent-based model.

Journal Articles Published 2021
Miranda Paez A, Sundaram M, Willoughby JR. 2021. Comparison of minimally invasive monitoring methods and live trapping in mammals. Genes 12:1949.

DeWoody JA, Mathur S, Harder AM, Willoughby JR. 2021. The long-standing importance of genetic diversity in conservation. Molecular Ecology. 30 4147-4154.

Journal Articles Accepted 2021
Harder A, Walden K, Marra N, Willoughby JR. 2021. High-quality reference genome for an arid-adapted mammal, the banner-tailed kangaroo rat (Dipodomys spectabilis). Genome Biology and Evolution.

Journal Articles Under Review 2022
Miranda Paez A, Chalkowski K, Zohdy S, Willoughby JR. Insights into the transmission and vectors of avian malaria. Parasites & Vectors.

Changes/Problems
I did not recruit a graduate student to work on objective 2 because I was concerned that covid shutdowns would delay the student's progress. I will reassess this in the next recruitment round.

Developing positive feedbacks between agriculture and conservation of freshwater organisms III

Project Director
Jim Stoeckel
Organization
Auburn University
Accession Number
1025477

Developing positive feedbacks between agriculture and conservation of freshwater organisms III

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

The southeastern United States hosts the greatest diversity of freshwater mollusks and crayfish in the world, with Alabama ranking first among all the states in mussel species and amongst the highest in gastropod and crayfish species. Unfortunately, population sizes and species diversity in Alabama are undergoing drastic, long term declines. Of all the states, only Haaii surpasses Alabama in terms of number of species lost to extinction. This represents a great loss to the state's natural resources and to agriculture. Healthy, diverse aquatic communities can enhance the ability of waterways to absorb excess nutrients and may be more stable and resistant to invasions of exotic species. The high biodiversity of organisms native to the southeast may also represent an extremely valuable but underutilized agricultural resource for new aquaculture products and low-cost ways to improve water quality in aquaculture ponds. Fortunately, increasing focus is being placed on restoring native biodiversity, developing sustainable agriculutral practices, and harnessing biodiversity for the wide variety of environmental and
economic benefits a healthy repository of species can provide.

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 next 5 years, I will continue to develop and promote positive feedbacks between agriculture and conservation. The Alabama Agricultural Experiment Station is uniquely well-positioned for this type of research. Experimental ponds and tanks can be used to produce large numbers of aquatic organisms for research purposes without depleting remaining populations in
natural systems. They can also be used to evaluate control techniques for invasive species, examine effects of pollutants and environmental stressors on aquatic organisms as well as evaluating the potential of using aquatic organisms to reduce pollutants through filtration and other mechanisms. Current techniques developed for aquaculture, such as cryopreservation of
oyster gametes, can be modified and applied to conservation of aquatic organisms. Techniques developed for ecology and conservation of aquatic organisms - such as aerobic scope - can be applied to assess and compare thermal tolerance of various genetic strains used in aquaculture. New techniques, such as those recently developed to age crabs and lobsters can be evaluated for use in conservation and aquaculture of crayfish. The intellectual and physical infrastructure supported by the AAES is critical for the success of future research programs focused on sustainable agriculturea and conservation of the worldclass
aquatic biodiversity found in Alabama and other parts of the southeastern United States.

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

Target Audience:
Academic Researchers
Natural Resource Managers
Students

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

Over the next 5 years, I plan to continue my research program to develop and promote positive feedbacks between agriculture and conservation. Main Goals/Objectives are as follows:
1) Interactions among anthropogenic inputs and aquatic communities. Examples include, but are not limited to:
a. Effects of agricultural inputs (sediments, nutrients, herbicides) on freshwater mussel and crayfish physiology and population
ecology.
b. Impacts of mussels and crayfish on water quality parameters (suspended sediments, algal blooms, mercury, etc.) in agricultural systems such as aquacuture ponds.
2) Development of new aquaculture products utilizing native species.
3) Adaptation and development/refinemen of techniques, tools, and approaches that can be applied to both aquaculture and conservation. Examples include but are not limited to:
a. Gamete cryopreservation techniques developed for aquaculture that may be applied to crayfish and mussel conservation.
b. Further development and validation of techniques to acurately age crustaceans for aquaculture and conservation purposes.
c. Development and evaluation of Aerobic Scope as a tool to address thermal tolerance issues in aquaculture and conservation.
d. Application of aquaculture production techniques and knowledge to study and develop control techniques for invasive species such as redswamp crayfish.

What was accomplished under these goals?
The southeastern United States hosts the greatest diversity of freshwater mollusks and crayfish in the world, with Alabama ranking first among all the states in mussel species and amongst the highest in gastropod and crayfish species. Unfortunately, population sizes and species diversity in Alabama are undergoing drastic, long term declines. Of all the states, only Hawaii surpasses Alabama in terms of the number of species lost to extinction. This represents a great loss to the state's natural resources and to agriculture. Healthy, diverse aquatic communities can enhance the ability of waterways to absorb excess nutrients and may be more stable and resistant to invasions of exotic species. The high biodiversity of organisms native to the southeast may also represent an extremely valuable but underutilized agricultural resource for new aquaculture products and low-cost ways to improve water quality in aquaculture ponds. Fortunately, increasing focus is being placed on restoring native biodiversity, developing sustainable agricultural practices, and harnessing biodiversity for the wide variety of environmental and economic benefits a healthy repository of species can provide.

In 2021 we conducted research on control measures for a popular southeastern aquaculture species - red swamp crawfish - that is shipped around the country and has escaped and become a high priority invasive, nuisance species in many states outside of its native range. Results from this research are currently being used to help control invasive red swamp crawfish in Great Lakes states such as Michigan. We also conducted multiple studies examining the effects of rising temperatures on crayfish, freshwater mussels, oysters, and shrimp. Results are being used by various agencies and research consortiums to develop environmental flow regulations for the conservation of freshwater mussels, to assess differences in thermal tolerance between invasive and native crayfish, to evaluate and produce genetic lines of oysters for increased temperature tolerance to help the off-bottom oyster aquaculture industry, and to help solve the problem of late-summer mortality for the low-salinity shrimp aquaculture industry. We conducted research on the effects of an emergent contaminant of concern - PFAS - on oysters in the Gulf of Mexico. Results thus far are showing little evidence for negative effects of PFAS on oyster health and little evidence that oysters are accumulating harmful levels of PFAS in their bodies. We expect these results will be very useful to the oyster aquaculture industry as well as agencies interested in food safety issues. Finally, we conducted research examining gamete production in freshwater mussels that provides valuable information for future efforts focusing on cryopreservation for conservation efforts.

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

Seven graduated students, one technician, and two undergraduates received training in 1) ecophysiology of mussels, oysters, crayfish, and shrimp pertaining to thermal stress, hypoxic stress, and chemical pollutants and 2) control techniques for invasive crayfish. They also attended and presented at multiple management agency and professional research conferences.

Results were disseminated at multiple agency and consortium virtural conferences and webinars that included academics, agency professionals, and various stakeholder groups. Results were also disseminated at multiple research conferences. Examples include but are not limited to the following:
• Stoeckel, J.A. 2021. Effects of suspended solids on freshwater mussel reproduction. Virtual Symposium: The protection

of freshwater mussels: Science and mitigation of sediment-related impacts. Hosted by USGS CERC, Columbia, Missouri. Invited speaker

• Reisinger, L.S., N. Tripp, and J.A. Stoeckel. 2021. Metabolic rates and behavior of a widely distributed crayfish shift along a latitudinal gradient. Society for Freshwater Science, virtual.

• Hussain, A.S., K.J. Fogelman, H. Abdelrahman, L.A. Roy, D.A. Davis, and J.A. Stoeckel. Relationship between aerobic scope and thermal tolerance of white-legged shrimp (Penaeus vannamei) in low-salinity culture systems. American World Aquaculture Society, San Antonio, TX.

• Boyd, K.T., K.J. Fogelman, P. Jordan, C. Figiel, and J.A. Stoeckel. 2021. Exploring linkages between physiology and thermal tolerance in crayfish and mussels. Southern Division American Fisheries Society, virtual.

• Elliott, G., A. Cupp, A. Allert, and J.A. Stoeckel. 2021. Evaluation of carbon dioxide as a control technique for invasive red swamp crayfish. Southern Division American Fisheries Society, virtual.

• Fogelman, K.J., J.A. Stoeckel, H.A. Abdelrahman, and B.S. Helms. 2021. A comparison of feeding ecology between lentic and lotic systems. SFAAS Student Research Symposium

• Fogelman, K.J., J.A. Stoeckel, H.A. Abdelrahman, and B.S. Helms. 2021. A comparison of feeding ecology between lentic and lotic systems. Alabama Fisheries Society Conference, Ramer, AL.

• Fogelman, K.J., A.S. Hussain, K. Boyd, P. Jordan, H.A. Abdelrahman, L. Roy, and J.A. Stoeckel. 2021. Using aerobic scope to evaluate thermal tolerance of aquatic invertebrates. Alabama American Fisheries Society, Ramer, AL.

• Jordan, P., K. Fogelman, A. Saied, and J.A. Stoeckel. 2021. Linkages between behavior, metabolic depression, and mortality of unionid mussels exposed to thermal stress. Freshwater Mollusk Conservation Society Symposium, virtual.

• Fogelman, K.J., J.A. Stoeckel, H.A. Abdelrahman, and B.S. Helms. 2021. A comparison of feeding ecology between lentic and lotic systems. Freshwater Mollusk Conservation Society Symposium, virtual

• Fogelman, K.J., A.S. Hussain, K. Boyd, P. Jordan, H.A. Abdelrahman, L. Roy, and J.A. Stoeckel. 2021. Evaluating the thermal tolerance of aquatic invertebrates using aerobic scope. Freshwater Mollusk Conservation Society Symposium, virtual

• Pieper, E., W. Haag, and J.A. Stoeckel, 2021. Methods for measuring bioenergetic parameters of small bivalves. Freshwater Mollusk Conservation Society Symposium, virtual.

• Boyd, K., V. Mulabagal, J. Hayworth, J.A. Stoeckel. 2021. Energetic costs of PFAS exposure and depuration in the Eastern Oyster. Auburn University College of Agriculture Research Poster Showcase, Auburn, AL.

• Fogelman, K.J., A.S. Hussain, K. Boyd, P. Jordan, H.A. Abdelrahman, L. Roy, and J.A. Stoeckel. 2021. Evaluating the thermal tolerance of aquatic invertebrates using aerobic scope. Auburn University Research Symposium.

• Elliott, G., A. Cupp, A. Allert, and J.A. Stoeckel. 2021. Evaluation of carbon dioxide as a control technique for invasive red swamp crayfish. Auburn University Research Symposium, virtual.

• Boyd, K., J.A. Stoeckel, J. Hayworth, and E. Irwin. 2021. Measuring energetic effects of PFAS on the eastern oyster (Crassostrea virginica) using respirometry. Auburn University Research Symposium, virtual.

• Hussain, A.S., K. Fogelman, H.A. Abdelrahman, L. Roy, and J.A. Stoeckel. Relationship between aerobic scope and thermal tolerance of white-legged shrimp (Litopenaeus vannamei) in low-salinity culture systems. 2021. Auburn University Research Symposium, virtual

• Fogelman, K., J.A. Stoeckel, H.A. Abdelrahman, and B.S. Helms. 2021. A comparison of unionid feeding ecology between lentic and lotic systems. Alabama Water Resources Conference, Orange Beach, AL.

• Boyd, K., E. Irwin, J. Hayworth, T. Bruce, J.A. Stoeckel. 2021. Energetic costs of PFAS exposure and depuration in the Eastern Oyster (Crassostrea virginica). Alabama Water Resources Conference, Orange Beach, AL.

• Horne, L.M., D.R. DeVries, and J.A. Stoeckel. 2021. Effects of glochidia infestation on metabolic rate and hypoxia tolerance of bluegill Lepomis macrochirus and largemouth bass Micropterus salmoides: implications for the field. American Fisheries Society, Baltimore MD

Funded research scheduled for 2022 will focus on thermal optima, thermal limits, and/or salinity tolerances of shrimp, oysters,
crayfish, and freshwater mussels as related to aquaculture and/or conservation; effects of PFAS compounds on oysters; evaluation of control methodologies for invasive crayfish. Techniques will include respirometry, enzymatic assays, gaping sensors, artificial burrowing chambers, and pond studies. Three papers (accepted pending revisions in 2021) will be published in 2022. Additional manuscripts are currently in prep and will be submitted in 2022. I continue to work with a collaborative invasive crayfish group in active discussions with GLRI, USGS, and USFWS to secure additional funding for crayfish control research. I will apply for additional funding opportunities in 2022 as opportunities arise.

Journal Articles Published 2021

Abdelrahman, H.A., R.L. Gibson**, K.J. Fogelman**, A.R. Cupp, A.L. Allert, and J.A. Stoeckel. 2021. Evaluation of dissolved carbon dioxide to stimulate emergence of red swamp crayfish Procambarus clarkii (Decapoda: Cambaridae) from infested ponds. Management of Biological Invasions 12(4):952-974.

Stoeckel, J.A., M. Szoka*, H.A. Abdelrahman, J.D. Davis, D.M. Blersch, and B.S. Helms. 2021. Crayfish chimneys function as burrow-ventilation structures. Journal of Crustacean Biology 41(3) ruab045.

Nichols, Z.G.**, V. Zadmajid, V. Dalal, J.A. Stoeckel, W. Wayman, I.A.E. Butts. 2021. Reproductive aspects of freshwater unionid mussel sperm: Seasonal dynamics, male-to-male variability, and cell quantification. Animal Reproduction Science 230: article 106786.

Westhoff, J.T., H.A. Abdelrahman, C.J. Rice, and J.A. Stoeckel. 2021. Linking multiple aspects of thermal performance to explore the potential for thermal resource partitioning between a native and an invasive crayfish. Journal of Thermal Biology 97: article 102864.

Haag, W.R. and J.A. Stoeckel. 2021. Demographic characteristics of young-of-year freshwater mussel populations in ponds. Hydrobiologia 848:311-320.

Alabama Professional Logging Manager (PLM) Trainings

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002306

Alabama Professional Logging Manager (PLM) Trainings

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

Alabama has 23 million acres of timberland and ranks third in largest commercial forest land in the United States. Logging is very important in the state economically and brings the need to train loggers in both sustainable forestry practices and logging safety. Professional Logger Manager (PLM) trainings and Continuing Forestry Education (CFE) training provide relevant content on the Sustainable Forestry Initiative (SFI) program, forest management, resource conservation and biodiversity, timber harvest practices for wildlife, threatened and endangered species, forestry best management practices for water quality protection, OSHA regulations, logging safety and hazards, and trucking regulations.

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 provided the necessary trainings and workshops to meet our goals of providing up-to-date and relevant knowledge on sustainable forestry practices at PLM trainings and CFE workshops.

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

Loggers and foresters have direct impact on Alabama timber and forestland and they benefited from our trainings and workshops by increasing their knowledge on sustainable forestry practices. Loggers that participated in the initial PLM trainings indicated an average of 58 percent increase in knowledge after completing the training.

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

Based on an annual harvest volume of approximately 40,177,166 tons of wood in Alabama and 2091 PLM loggers, it is estimated that the 2021 PLM and CFE participants had direct impact on 28% of the tons of wood harvested in Alabama. This is benefiting Alabama landowners in that loggers and foresters will be practicing sustainable forestry practices on their properties. Loggers and foresters work directly with Alabama landowners in managing their timber or forestland which in turn benefits the communities (landowners) across the state.

Aquaculture/Aquaponics Education

Project Director
Rebecca Barlow
Organization

Auburn University
Accession Number
7002287

Aquaculture/Aquaponics Education

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

Aquaculture is also the fastest growing segment of aquaculture worldwide. It now provides more than 50% of the United States edible seafood supply. Scientists predict that aquaculture production will have to triple in the next 30 years just to meet the demand created by increased population.

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 utilized a 3-pronged aquaculture/aquaponics education, demonstration, and training approach to target 1) Teachers and students, 2) Producers, researchers and Extension agents and 3) The general public.

Activities in this project took many forms including hands-on programs, virtual programs via zoom, site visits and information delivery via YouTube videos. Many teachers and students broadened their horizons by visiting or participating in the program activities. I hosted 427 people in 56 groups for tours/presentations at the E.W. Shell Fisheries Research center, 3 guest lectures for Auburn University classes, provided 10 HS school visits, provided 5 guest lectures via zoom to HS classes, 1, 5-day Aquaponics 101 workshop for 14 teachers from 5 states, and 2, 5-day “Fish Camps” for 34 students from 6 states.

Producers, researchers’ educators and agent participated in 3 webinars co-sponsored by the United States Aquaculture Society, the National Aquaculture Association and the Alabama Cooperative Extension System. Four additional webinars/online presentations were hosted by Legacy, Partners in Environmental Education, ACES Master Gardener, SMART Backyards. More than 500 people participated from 50+ countries.
The internet has made sharing information with the public much easier. The COVID 19 pandemic in 2021 made these electronic resources even more critical and valuable as we were not able to meet with clients in person. Several years ago, I created a YouTube channel called Aquaculture Education and More to expand the reach of content on the ACES YouTube Channel and group great aquaculture information in one place. This effort has been very successful in reaching and educating people interested in aquaculture and aquaponics. In 2021, the aquaculture/aquaponics videos on these channels received 140,471 views from 60+ countries. Utilizing this method to educate others allows us to be everywhere at once and multiply our efforts. There were 9,250 hours of video watched which equates to an additional 4.62 FTE of faculty working 100% of their time providing educational opportunities. The value of these additional FTEs to Alabama and beyond is $621,704.

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

Teachers that attended the 5-day Aquaponics 101 workhop increased thier aquaculture/aquaponics knowledge by 31% (pre/post testing). They also placed a monetary value on the information and tools at $842, 2.5 times the cost of the workshop.

Those producers/researchers/Extension personnel that attended the online trainings gained valuable information to advance their respective fields. Based on survey information collected early in 2020 the attendees put a value of $180 per hour of education. In 2021 attendees and online views of the 2021 webinars totaled 2014 hours x 180 = $435,240.

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

The on-demand aquaculture training videos placed on the YouTube Channels recieved 140,471 views providing 9,250 hours of education.

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.

Article published in the world aquaculture magazine and facebook and instagram posts. There is a lot of interest in small scale aquaponics. Training to dispel aquaculture myths and the health benefits of eating seafood farmed or wild.

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.

Oyster gardening contributes to reef site restoration in local areas benefit by way of increased ecosystem services and the corresponding value of the restored acreage. Participants are better equipped to understand how oysters function in their local estuaries. Further, through this participation participants are able to grow their programs by sharing their experiences.

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. 2021 proved particularly opportunistic relative to the impact of freshwater on local shellfish. Inspite of difficult growing conditions, stakeholders and participants achieved a positive restoration potential by growing more than 60,000 oysters ready to be planted on restoration sites in Alabama and Mississippi.

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

Participants are better equipped to understand how oysters function in their local estuaries. Further, through this participation participants are able to grow their programs by sharing their experiences. Restored reef sites in local areas benefit stakeholders by way of increased ecosystem services and the corresponding value of the restored acreage.

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

Restored reef sites in local areas benefit by increasing ecosystem services and restored acreage. A deeper and more dynamic understanding of estuarine ecology, the importance of oysters above culinary, and the impact individuals off the coast, up in the watershed, can have on the health and longterm well being of coastal environments.

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 are considering delaying distribution of Mississippi oysters in 2022 to get past spring rains which appear to be a growing issue. this will come at the cost of several weeks of participation.

Systems approaches for improving forage-based beef cow-calf production in Alabama

Project Director
Mary Mullenix
Organization
Auburn University
Accession Number

Systems approaches for improving forage-based beef cow-calf production in Alabama

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

In Alabama cow-calf operations, the environment is especially conducive to growing a variety of both cool- and warm-season forages in support of cow-calf and post-weaning development of beef cattle. Forage management and nutrition are primary input costs in beef operations that can be optimized through the adoption and implementation of best management practices.

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

Given the current volatility in concentrate-feed prices that is expected to continue into the future, forages offer options for adding value to beef cow-calf operations locally with less expense, lower input volatility, and lower overall dependence on concentrate feedstuffs. For these reasons, research leading to development of sustainable forage systems that reduce dependence on concentrate feedstuffs and throughout the entire beef supply chain is needed. Development of forage-based beef production systems management strategies necessitates research to evaluate potential strategies for cow-calf pairs, backgrounding growing calves, and development of replacement heifers. The goals of this project are to 1) evaluate beef cattle
performance from integrated forage-supplementation systems based on regionally adapted annual and perennial grass species
using accepted field, laboratory, and statistical methodologies, and 2) to determine strategies for enhancing beef calf production
post-weaning through added-value systems management practices. Expected outputs include the development of applied research recommendations for improving the soil-plant-animal interface in Alabama beef cattle operations, training of graduate
students and post-doctoral fellows in the area of beef-forage management systems, and integration of data generated from this
project into Extension educational decisions tools for stakeholders. Long-term impacts of this project include increased awareness and on-farm adoption of sustainable forage-animal management practices in Alabama.

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

Target audiences reached in 2021 include both internal and external stakeholders. Internal stakeholders include animal science faculty, graduate students, and post-doctoral fellows in the beef-forage research/Extension program team. Results from current research are disseminated through various outlets, including directly to end users of the information. End users include Extension agents and beef/forage livestock producers in the Southeast US. Research summaries were disseminated to these audiences through both in-person and web-based educational products including presentations, publications, popular press articles, short summaries, workshops and social media.

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

Beef systems specific projects were developed and implemented to address the goals of 1) improving nutritional management
efficiences in cow-calf operations and 2) determing strategies for enhancing beef calf production through value-added management practices. Projects included the following and key findings are reported for each study. Associated outputs are reported in the 'Products' and 'Outputs' sections, respectively:
Integration of alfalfa into bermudagrass systems in the Southeast US for extending the annual forage production season -
The development of newer alfalfa cultivars with improved adaptation to local growing conditions and dual-purpose applications has increased alfalfa incorporation into grass systems in the southern US. The complementary growth of both species helps to extend the forage production season length, decreasing producer reliance on supplementation. The objective of this study was to determine forage mass (FM) and nutritive value, botanical composition, and structural responses of alfalfa-bermudagrass systems managed under five stockpiling strategies (6-, 8-, 10-, 12- and 14-weeks of accumulation) in Shorter, AL. A randomized complete block design with eight replications was used. Harvested forage samples were manually separated into individual components and placed into 60° C until constant weight, then weighed. Measurements of ground

cover, and alfalfa density and persistence were taken prior to plot harvest. There was a treatment × year interaction and greater FM was observed for 10- and 12-wks of regrowth (4,279 and 4244 kg ha-1, respectively) in Year 2. This response was associated with greater bermudagrass percentage in the mixture in Year 2 than 1 (averaged 57 vs 23%, respectively). Weeds remained below 4 % in both years. There was a direct relationship between increased regrowth period length with leaf shattering and lodging. Over 10-wks of regrowth, percentage of lodging was >30% and rate of leaf shattering doubled. This response directly affected leaf area index observed for the alfalfa-bermudagrass mixtures at 14-wk with a reduction of 30% when compared to 6-wks regrowth (2.6 vs 3. 9, respectively). Greater digestibility was associated with shorter regrowth period (6-wk), although the values observed ranged from 62 to 87% which represents high nutritive value forage that can meet higher animal requirements. Based on results, stockpiling alfalfa-bermudagrass mixtures using varying accumulation period lengths may be a viable system to provide high quality feed and extend the grazing season length into the fall and winter. This can also be an important strategy aiming to increase diversity and sustainability in forage-based livestock systems.
Post-weaning management practices for cow-calf operations - Alternate weaning methods and backgrounding periods are strategies to reduce calf morbidity and mortality at feedlot arrival. The objective of this study was to assess the collective effects of weaning and post-weaning management practices on potential carryover effects on calf health and performance through the backgrounding phase. A total of 2 16 steer calves (average BW, 298 kg) from three Auburn University research farms were randomly assigned to one of three different weaning method groups: Fenceline weaning, nose-flap weaning, or abrupt weaning. Calves were weighed on d 0 and d 14 post weaning, and then began a 60-d preconditioning period. Calves were randomized according to previous weaning management, farm of origin, and body weight to one of three nutritional management strategies in a 3 × 3 factorial design: cool-season baleage (oats, ryegrass and crimson clover) and 1% BW dried distillers grains (DDGS), bermudagrass hay and 1% BW DDGS, or grazing mixed warm-season annuals and 1% BW DDGS. Calf body weights were collected on d 0, d 30 and d 60 of the backgrounding phase. Weights did not differ during the weaning phase but calves in the fenceline group had the greatest average daily gain (1.13 kg/d) during this phase. There was a weaning × backgrounding treatment interaction for average daily gain during the first 30 d of the backgrounding phase. Calves
that were fenceline weaned and on the cool season baleage diet had the highest average gain at 1.02 kg/d, whereas abruptly weaned calves on the grazing diet only gained 0.29 kg/d in the first 30 d. Steers on the cool season baleage diet had the greatest total gain at 45.8 kg over the course of the 60-d period. These results indicate that backgrounding diet, coupled with weaning management strategies, may influence calf performance during the transition period for calves into the post-weaning
phase.
Evaluation of byproduct feedstuff quality characteristics for use in beef cattle diets - Cotton is grown on over 4.5 million hectares in the Southeast US annually, and byproducts of cotton production are utilized as feedstuffs in beef systems. Cotton breeding efforts and variety recommendations for crop production represent potential changes in cotton seed size, density, and quality, which may influence whole cottonseed feed quality characteristics. Also, cotton breeding to reduce gossypol concentration without compromising yield may improve value in ruminant diets. A recent feed intake trial demonstrated greater consumption of ultra-low gossypol seed compared with seed derived from a more widely planted cotton variety (0.072% vs 0.53% free gossypol, respectively) in growing steers (1.9 and 1.1 kg/hd/d, respectively). Historically, cottonseed is limited in bull diets due to the associated of decreased fertility in males due to gossypol. However, a recent study found that feeding up to 3.2 kg/hd/d over a 60-d period to developing beef bulls did not affect sperm quality. Heat damage commonly occurs in cottonseed during storage after the ginning process, but the feed value of heat damaged cottonseed is unknown. A recent study indicated that in situ dry matter (52.2 vs 69.2 %) and N (78.1 vs 91.6%) disappearance decreased for heat damaged compared to normal cottonseed, respectively. Cotton gin trash remains a prevalent byproduct with traditionally limited use. Some gins have equipment for baling gin trash in 180-to-270 kg modules, which allow ease of access and transport of gin trash waste for cow-calf producers. Similar to gin trash, grazing cotton crop residue after harvest can decrease the amount of hay fed during the winter. A recent 3-yr study indicated a 2.5 hd/ha stocking rate of mature, nonlactating
cows over a 30-d period decreased hay consumption by 65 %. By understanding the feed characteristics and management needed to utilize cotton byproducts, cattle operations can decrease feed cost while maintaining animal performance.

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.

These projects are part of the body of work associated with one Ph.D. student program in the beef-forage discipline area (Maggie Justice), and one M.S. program. One M.S. student completed their program in 2021 and is continuing their education at the doctoral level in Animal Sciences at Clemson University. This work has also supported three undergraduate student

research assistants and a post-doctoral fellow in beef-forage research and Extension in the Department of Animal Sciences. Dr. Liliane Silva completed her post-doctoral fellowship in October 2021 and was hired as an Assistant Professor/Forage Extension Specialist at Clemson University.

Results have been communicated to both scientific and non-scientific audiences through various product creation, release and promotion. For scientific audiences, project abstracts were developed and presented at the American Society of Animal Science Southern Section Meeting, the American Forage and Grassland Council Annual Meeting, and the Southern Pastures and Forage Crop Improvement Conference. Research on byproduct feedstuffs has been invited for a subsequent review paper to be published in the Applied Animal Science Journal in 2022. Results summaries have been incorporated into Extension education program delivery through the Alabama Beef Systems Extension program. Where applicable, results are included in presentations, peer-reviewed Extension publications, and in web-based educational resources such as websites, online courses, and social media.

Continued research will be conducted with legume integration into bermudagrass systems and post-weaning cow-calf management systems for 2022 and beyond. Multi-year data will enhance forage management recommendations for end users.

Journal Articles Published 2021
Silva, L.S., M.K. Mullenix, C.G. Prevatt and J.J. Tucker. 2021. Perceptions on adoption of alfalfa plantings by foragelivestock producers in the southern US. Applied Animal Science.

Gunter, P.A., M.K. Mullenix, L.C. Burdette, and R.B. Muntifering. 2021. Evaluation of nitrogen-delivery methods for stocker cattle grazing annual ryegrass. Translational Animal Science. 5:2. doi.org/10.1093/tas/txab048.

Journal Articles Awaiting Publication 2022
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The ACES Forage Focus Program: Growing Grass, Growing Profits
Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002291

The ACES Forage Focus Program: Growing Grass, Growing Profits

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

Forage crops represent the largest (by acreage) commodity in Alabama. Stakeholders need informaton regarding forage growth and harvest, forage pests, forage weeds, forage varieties, and development of forage systems across the state.

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

In 2021, 64 individual Zoom and in-person activities were held in support of the Forage Focus program. A total of 1,004 participants (758 male and 246 female). In state participants totaled 895, with 109 out-of-state attendees. State-wide events included the 2021 Alabama Forage Conference, 2021 Alabama Grazing Academy, Beef Systems Short course, Bermudagrass Hay Growers Summit. Regional events included the Wiregrass Research and Extension Center Beef and Forage Field Day, The Tennessee Valley Research and Extension Center Beef and Forage Field Day, West Alabama Beef and Forage Conference. Other activities included County Cattleman's Meetings, farm visits, Extension publications, and social media posts. The Alabama Grazing Academy was initiated in 2018 as a regional/state program. Due to COVID, only 1 event was held in 2021 with 26 attendees. Attendee knowledge of precision soil fertility increased by 0.6 pts (Likert scale; n = 8), grazing management knowledge increased by 1.0 pts, grazing management knowledge increased by 1.3 pts, temporary fencing knowledge increased by 1.3, and weed management knowledge increased by 0.7 pts as a result of the workshop. Participants were very likely (4.9/5.0; n = 7) to implement a change in grazing management strategy in the next 12 months. The total economic impact of the meeting was $56,342, with an average of $2,167 impact per farm.
During 2021, online videos and posts played an increasing role in outreach of the Forage Focus Program. The Forage Focus Facebook page had a total of 1,993 likes and 2,258 followers at the end of the 2021. A total of 7,300 minutes of video were viewed by individuals (non-promoted views) with 13,600 individual viewers, of which 1,100 engaged with the video. Of these video viewers, 64.5% were not followers of the Forage Focus Facebook page. YouTube videos received 6,162 views in 2021.
In 2021, the Forage Basics online course was released. This is a fist of its kind course in the Southeast. Since its release in September, 255 participants have enrolled in the course. Participants have 180 days to complete the course, so accurate completion rates cannot be calculated at this time.

Digital and in-print resources were also created to support the Forage Focus Program. In 2021, the ASF Quarterly Newsletter was released. This project is organized by 1 CEC and 1 REA on the Animal Science and Forage Team and was released in Spring 2021. By the Winter 2021 issue (released early December 2021), the newsletter had 380 subscribers with 200 individuals opening at least 1 article in the newsletter (52.6% engagement rate). Six peer-reviewed publications were released on topics ranging from Decreasing Horse feeding costs to Adjusting stocking rate and Management and care of the dry dairy cow. Eight technical articles were written for ACES.edu including extending winter grazing, Forage Soybeans, and management of sugarcane aphids. One international popular press article was written and published in the Canadian Progressive Dairyman-French edition, as well as two national-level popular press articles. Three regional articles were published and 8 in-state articles in the Alabama Cattleman's and ALFA's Neighbor magazine.

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

The target audience benefits from this program by being provided information to increase economic, social, and environmental sustainability of their forage-based livestock systems.

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

Sustainable forage productive provides value to the public though ecosystem services (e.g., reduced soil erosion, carbon sequestration), improves animal welfare and increase food supply chain security, and provides land conservation and wildlife habitats.

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 of the Forage Focus program are disseminated through a variety of formats in order to reach the maximum number of clientele as possible. Extension specialists, REA, and CEC provide one-on-one interaction with clientele via telephone, email, teleconferencing, or on-farm meetings, as well as in group meetings. Educational products such as popular press articles, peer-reviewed publications, online courses, and social media posts are released regularly to provide up to date information to the target audience. Digital content is released through Extension and commodity listservs, as well as through social media posts. Due to reluctance to attend in-person meetings as a result of COVID 19, multiple in-person programs were cancelled or transitioned online.

Water and Watershed Management

Project Director
Rebecca Barlow
Organization
Auburn University
Accession Number
7002301

Water and Watershed Management

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. All stakeholders have a role in water and watershed 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.

Outputs directly aided in completion of set objectives. Over 80 (PWP) + 270 (AWS) + 678 adults and 870 youth (AWW) participants involved in program offerings. Significant increases in knowledge from participants involved in workshops. Over 400 participants were reached during ACF River Basin Drought and Water Webinars. Over 30 producers reached during farmer scoping meetings for the Middle Alabama River Basin Sustainable Irrigation Expansion Initiative.

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

Direct benefit between target audience and delivered outputs. Educational offerings and supplemental resources were made available in the form of online trainings, in-person workshops, printed materials, and direct consultations.

Alabama Private Well Program
Over 80 participants (audience of Extension and industry personnel) attended bi-weekly Lunch and Learn sessions hosted by the AL Private Well Program. By the end of the series, participants knew where to find resources regarding private wells, and were likely to recommend the series to others interested in learning about private wells.

Alabama Watershed Stewards
Engineering and Design Professionals: Gained four professional development training courses about specific low impact development technologies. Strengthened network connections and grew capacity for green technology in Alabama.
Teachers and educators: Gained additional freely accessible resources (including the online course) to use in environmental education outreach.
General citizens: Gained trainings and resources on how to better implement best management practices in their personal and professional lives to reduce non-point source pollution.

Alabama Water Watch
Citizens gain awareness and knowledge surrounding water quality issues and monitoring through participation in AWW trainings and presentations. Citizen monitors collected a total of 3,651 water data records that enabled them to identify and correct pollution issues and protect high quality waters. Educators increased their capacity for engaging students in aquatic science and water quality monitoring.

ACF River Basin Projects
Water professionals were provided with critical resources and updates to make informed decisions regarding water management in the ACF Basin. Stakeholder input was used to produce new, interactive, real-time, and easy-to-interpret drought and water conditions tools that are specifically tailored for the ACF Basin.

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

Both directly and indirectly. Directly through attendance in scheduled workshops/trainings, and indirectly through dissemination of information from other professionals taking part in trainings.

Addressing the threats of non-point source pollution requires a broad number of stakeholders working together to improve water quality. As a science-based program, AWS's educational resources are uniquely positioned to educate citizens about how to reduce non-point source pollution. Adult decision makers are rarely encouraged to reflect on their role in contributing to pollution, by focusing on action-based solutions and broad citizen involvement, AWS encourages the public to take local action to improve and protect Alabama's natural resources.

AWW data serves as a tool to protect and restore Alabama's water resources. Many different entities utilize the data including the Alabama Department of Environmental Management (ADEM). Each year, ADEM requests all AWW data from the past five years to be utilized in assisting ADEM to determine if a waterbody is meeting the specific water quality standards set for its use classification and to focus water quality monitoring priorities each year. In 2021 alone, volunteers collected 3,651 water data records. Data collection of a similar magnitude by ADEM would cost the state over $682,316. Additionally, AWW continued work with the USDA Forest Service to support a network of volunteer water monitors in National Forests in Alabama (NFAL). AWW volunteers submitted 144 water data records collected from waterbodies within NFAL priority watersheds identified through the USFS's Watershed Condition Framework.

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.

Information was disseminated to communities of interest via email correspondence, social media, newsletters, webinars, in-person encounters, YouTube videos, publications, professional conferences, AU WRC website, local news channels, etc.

In 2022, efforts will be made to make workshops more interactive and to reach a wider audience range. People have expressed difficulty with finding articles on the ACES website so efforts will be made to make those articles easy to find via social media or other outreach efforts.

In response to the pandemic, AWW developed online courses, which enable AWW to train citizens very little in-person interaction. Therefore, it can be expected that the number of citizens trained in 2022 will be greatly increased. It is also hopeful that the different training approach will help AWW to reach audiences that have typically not been involved due to the time requirements of traditional trainings.

E-waste Management Education Program (EMEP)

Project Director

Kimberly Holmes

Organization

Alabama A&M University

Accession Number

7002344

E-waste Management Education Program (EMEP)

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

Managing e-waste is a global challenge. The number of electronic products in households and businesses considered obsolete, broken, or irreparable is growing at a tremendous rate, making e-waste the world's most rapidly growing waste stream. According to a United Nations report, 52.7 million tons of e-waste were generated worldwide in 2019. The Global E-waste Monitor reported an estimate of around 57.4 million tons for 2020, with projections of 74 million tons by 2030. Continued production of e-waste in such a rapid manner creates a need for improved education and increased adoption of e-waste best management practices (BMPs) that reduce costs and environmental impacts associated with new electronics production. Furthermore, recycling electronics prevents ecological degradation, reduces waste, and helps create local job opportunities. In addition, many of the metals used in manufacturing are nonrenewable resources and even rare earth minerals that will not be replenished during our lifetime. Therefore, the conservation of these nonrenewable resources is crucial.

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 outputs enhanced Extension's ability to provide e-waste education. They increased citizens' knowledge and awareness of e-waste hazards, increased adoption of recommended BMPs, and reduced the amount of e-waste fated for landfills and the environment. The e-Stewards Global Impact E-waste Calculator was applied to determine eco-impact from the eight e-waste recycling drives. It calculates and sums greenhouse gas (GHG) emissions of baseline and alternative waste management practices. The application (App) calculates environmental impact by determining toxic metals diverted from landfills, dumping or disposal, critically valuable metals saved, and the greenhouse gases avoided by recycling responsibly. Results from the Clover Imaging Group Environmental Calculator revealed the following ecoimpact data. The recycled printer cartridges are equivalent to offsetting CO2 emissions from more than 38.7 gallons of gasoline. It is also equivalent to the carbon sequestered by 5.73 tree seedling(s) grown for ten years and 0.45 acres of pine or fir forests. The printer cartridge recycling efforts alone yielded 269 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 and diversion of toxic metals from entering the environment and considerable cost savings, socially, economically, and environmentally. Overall, outcomes included conserved energy and natural resources, reduced environmental pollution, and increased economic gains.

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

The target audience was diverse, including volunteers, homeowners, business owners, and the general public. 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.). This includes revenue for the recyclers associated with the project and cost savings for the general public. According to Energy Central, over 375 million empty ink and toner cartridges are thrown out every year, some taking up to 1000 years to decompose thoroughly once in a landfill. In addition, many of the materials found in printer cartridges can be extremely damaging to the environment, especially soil and aquatic resources. Since nearly 97% of these materials can be recycled, outreach education that responds to e-waste management is becoming increasingly important worldwide. The outputs led to expanded delivery of this information and the increased benefits of responsibly managing e-waste. The homeowners and public, in general, benefited significantly from gains in understanding and improved environmental conditions due to reduced e-waste contamination and decreased carbon emissions (CO2). In short, the program had enormous impacts that demonstrated the significance of good environmental stewardship to individuals, businesses, and communities.

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

The benefits to the broader public are demonstrated in the e-Stewards Global Impact Ewaste Calculator results, revealing that the recycling events deferred 63,979 lbs. of carbon emissions (CO2) from entering the atmosphere diverted 1,319 lbs. of toxic metals from entering local landfills. These activities also saved over 15,501 lbs. of critical precious metals, including 1.17 lbs. of gold, 2,027 lbs. of copper, 939 lbs. of aluminum, and 12,532 lbs. of steel. Approximately sixteen different precious metals can be recovered from e-waste via various processes. Notably, mining for new metals is an economically costly and carbon? intensive process with potentially detrimental impacts on the environment. The Ecosible Carbon Footprint and the WEEE4Future E-waste Calculators further underscore the impacts of the project's outputs on the broader public. Estimations were determined employing values for targeted inputs, including the number of laptops, monitors, and computer towers. Results of the Ecosible Calculator indicated that the observed recycling efforts were equivalent to 654 trees being saved or the production of 24,604 plastic bottles, or 10,918 gallons of gasoline [@ $3.75 per gal. = $40,942.00]. The WEEE4Future E?waste Calculator revealed that the efforts yielded CO2 savings equal to a 1233?mile drive. The application of additional EPA conversion factors showed that 45,900 lbs. of e-waste would help save 95,042,376 hours of electricity [Montgomery County Environmental Calculator (Maryland, USA). These are all improved environmental conditions or outcomes that impact the broader public. In short, e-waste was disposed of properly, precious resources (i.e., copper, steel) were preserved via recycling processes, and knowledge gains were observed on the various types of e-waste, risks associated with ewaste, and the benefits of reusing and reducing recycling e-waste. The outputs also helped to create new local job opportunities. To this end, these outcomes are significant and provide social, economic, and environmental advances for Extension's clientele.

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.

Notably, the onset of the COVID-19 pandemic resulted in unprecedented challenges. In some ways, it presented new opportunities to advance environmental education, ultimately catalyzing innovations in program delivery. Nonetheless, many issues persist with Covid-19 restrictions confining program delivery, implementation, and evaluation, especially where face-to-face interaction with people and nature is essential. Also, problems with limited internet access, broadband, and the use of technology are enormous challenges. Additionally, the types of e-waste accepted by recyclers continuously change, which dramatically impacts the quantity of what can be recycled. Weather also affects participation in outreach programs.

COVID-19 greatly impacted the team's potential to share findings at local and national conferences, meetings, and symposiums in the traditional way. Nonetheless, there were forums where outcomes were shared face-to-face. They included Earth Day events in Huntsville, AL (n=488), and several citywide e-waste drives throughout the state. Program impacts were highlighted in local newspapers, success stories, and state and federal annual reports. Information and outcomes were also shared with communities of interest using radio, television, newsletters, magazines, and internet online media sources like Facebook, Twitter, and Instagram. Interestingly, COVID-19 increased social media for promotion, marketing, and delivery. The virtual programs yielded Instagram Impressions of 41 and Engagements of 209, along with hundreds of online page views for e-waste content, including videos.

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 Pharmaceuticals Impacts on the Environment (SerPIE)

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

According to the Associated Press, concentrations of pharmaceuticals have been found in the drinking water supply of nearly forty-one million Americans. These chemicals' potential toxicity remains unknown, and that uncertainty poses an immense threat to human, animal, and environmental health worldwide. SerPIE aims to reduce the number of pharmaceuticals fated for the environment and stockpiled in homes by promoting positive behavior changes and the adoption of recommended

pharmaceutical best management practices (BMPs). In addition, the program seeks to advance knowledge and promote the benefits of using safe, effective methods to dispose of expired, unused, and unwanted pharmaceuticals and personal care products (PPCPs).

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 team of five UREAs and one State Specialist carried out 48 SerPIE activities, reaching 1,279 inperson, online, and virtual clients through the program; a total of 9,643 indirect contacts were made. They utilized portable 3-D Enviroscape models, an interactive curriculum, and a drinking water quality video, with 1,137 YouTube views to date. Over 530 Deterra drug deactivation systems were shared with stakeholders. A total of 315 "Go Green Bags" were distributed, 87 lock-your-meds pledges, and 3,486 direct mailers promoting the DEA National Prescription Drug Take-back Program were mailed out in six Alabama urban cities. Seven new partnerships, including Jefferson County Environmental Services Water Quality Division, Dale County Spectracare, Choctawhatchee Riverkeeper, and Quest Diagnostics, were forged. The Team also partnered with local police to provide eleven drug take-back programs. Three new permanent drug drop-off boxes were installed in Mobile and Enterprise, AL. Annual reports were obtained from each of the drug drop-off locations. The Team disseminated an estimated 1,325 brochures, 450 publications, and 880 flyers during the programming year. Program outputs for SerPIE related activities revealed Instagram impressions of 18, Instagram Engagements of 117, a Facebook Reach of 2575, Engagements of 131, and over 262 total online page views.

Several virtual, hybrid and in-person programs were offered throughout the year to provide resources aimed at helping citizens safeguard their homes and the environment from PPCPs. These outputs led to gains in literacy and minimized impacts of PPCPs on human, animal, and environmental health. Through four webinars, program participants learned the benefits of using safe, effective methods to dispose of expired and unwanted medication. Further, the amount of PPCPs stockpiled in homes and fated for the environment was lowered significantly through ten drug take-back events and the use of thirteen permanent drug drop-off boxes. Drug take-back participants (n=651) dropped off approximately 2,100 lbs. of medication. The permanent drug drop-off boxes received approximately 1,175 lbs. of medication, yielding a total of approximately 3,275 lbs. of expired and unwanted medication. The majority of the medication were prescription drugs, followed by over-thecounter (OTC) medicines. This significantly reduced the accessibility and potential misuse and abuse of drugs among adults and teens.

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

Participants were engaged via several virtual webinars, demonstrations, and online media (n=139). Post survey results indicated knowledge gains and the adoption of recommended pharmaceutical and veterinary BMPs, including animal producers. Participants learned the benefits of properly disposing of PPCPS, how pharmaceuticals enter waterways, and the human, animal, and environmental health hazards associated with improperly disposing of medications. Participants also learned about the growing problem of prescription and opioid drug abuse and how it indirectly contributes to PIE. Results showed that 53% of respondents had participated in a local drug take-back program, 55% had dropped off unwanted medicine at a local police station or pharmacy drug drop-box, and 50% had taken the lockyour-meds pledge. Ninety-five percent of the respondents planned to share what they learned with family and friends. Participants' responses to the virtual webinars were as follows: Great Presentation Today and Awesome Workshop.

Pre/post-test measures, post-delayed surveys, online hits and visits, polling during interactive presentations, and online surveys utilizing QR codes were used to measure program effectiveness. Program outcomes revealed anticipated positive changes in behavior for the participants. Moreover, In addition, the majority of the participants surveyed stated that they were able to achieve an environmental expectation of protecting the environment from pharmaceutical drug contamination and a social expectation of providing a drug-free, safer, and securer home for their families.

Overall, the reduction in PPCPs improved social, economic, and environmental conditions for Extension's clientele. Participants are now better equipped to manage and dispose of their unwanted medicines and are aware of their adverse actions. New partnerships with organizations like Verde Environmental Technologies have also increased PIE awareness among underrepresented populations.

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

Pharmaceuticals in the environment are not just a local problem; they are being detected in the environment by scientists all over the world. SerPIE helps individuals understand the environmental safeguards germane to proper management and disposal of unwanted medicine. The pandemic use, misuse, and abuse of prescription and opioid drugs only perplex the problem in both rural and urban areas. The DEA National Prescription Drug Take-Back Day Program has collected more than 15 million lbs. of drugs since its inception. More than 101,000 lbs. came from Alabama alone. In April 2021, Alabama had 58 collection sites and 5,100 lbs. of drugs collected and 57 collection sites, and 4,708 lbs. of drugs collected in October. The outreach efforts of the SerPIE program have tremendously impacted the overall numbers. The amount of PPCPs stockpiled in homes and fated for the environment has declined drastically due to SerPIE. The program outputs have decreased soil and water pollution, improved public health, resulting from less PIE, and reduced misuse of easily accessible drugs. There has also been increased adoption of recommended best management practices (BMPs).

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.

Notably, the onset of the COVID-19 pandemic resulted in unprecedented challenges. In some ways, it presented new opportunities to advance environmental education, ultimately catalyzing innovations in program delivery. Nonetheless, many issues persist with Covid-19 restrictions that confine program delivery, implementation, and evaluation, especially where face-to-face interaction with people and nature is essential. Also, problems with limited internet access, broadband, and the use of technology are enormous challenges. It is also particularly challenging when there is limited access and a need to determine the outcomes of youth programming.

Program results were disseminated to communities of interest using radio, television, newsletters, magazines, University bulletins and calendars, and online internet sources (i.e., Facebook, Twitter, Instagram, ACES website, Blogs, etc.). Presentations were delivered at the 2021 Annual Alabama Water Resources Symposium and Conference in Orange Beach, AL, on September 8-9, 2021. They included an oral presentation entitled "Employing A Dynamic One Health Approach in Extension and Outreach to Reduce Impacts of Pharmaceuticals and Personal Care Products (PPCPs) on Water Quality" and a poster presentation entitled "Incidence of Pharmaceutical and Personal Care Product (PPCP) Contamination in Alabama Waters." In addition, a presentation entitled "Minimizing Pharmaceutical Impacts in the Home and the Environment Utilizing a One Health Approach was accepted to the AEA 2021 System-wide Extension Conference in Orlando, FL, that was rescheduled for Summer 2022 due to the COVID-19 pandemic. A scientific article entitled "Detection of Human Pharmaceuticals in the Surface Water of East Fork Stones River" was published in the Journal of Water Resource and Protection. A second research article entitled "The Presence of Contaminants of Emerging Concern (CECs) and Volatile Organic Compounds (VOCs) in Northern Alabama Aquatic Ecosystems" was published in the Journal of Environmental Science and Engineering. Several online blog articles and PSAs were provided to reach the DEA National Prescription Drug Take-Back Day communities of interest. Program impacts were also highlighted in local newscasts and newspapers, newsletters, and state and federal annual reports.

Urban Environmental Science Education Program (UESEP)

Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002383

Urban Environmental Science Education Program (UESEP)

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

As urban communities continue to grow and expand, topics such as soil and water pollution, wildlife management, and natural resource conservation are progressively becoming a concern for many families. Protection of the environment and its resources is vital. The future lies in our citizens' hands; therefore, their level of knowledge concerning environmentally-related issues is crucial. Alabamians must be prepared to make a conscious effort to protect the environment whenever possible.

Knowledge and understanding of environmental issues are essential tools for such in-depth involvement. UESEP promotes positive behavior changes toward forestry, wildlife, and natural resource management, providing citizens with a framework to become better environmental 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.

A team of five UREAs and one Extension Specialist carried out 200 UESEP activities, including virtual, hybrid, in-person workshops, webinars, interactive demonstrations, field days, storytime sessions, and explorations focused on environmental issues. A total of 7,247 in-person, online and virtual clients were reached through the program, and 122,188 indirect contacts were made. Five (5) extension articles were written, and one (1) peer-reviewed scientific paper was published. Nine (9) youth joined the Teen Nature Club, and eighteen (18) new nest boxes were installed on birding trails. Six (6) continuing education units (CEUs) were awarded to educators participating in the Camp Conservation for Teachers Professional Development Series. The Team also worked with local partners to certify eight (8) new arborists. Numerous marketing tools and four (4) new web-based curricula were created. Nine (9) educational videos were developed, Fourteen (14) new partnerships were established, and two (2) virtual water festivals were offered.

Over 4650 lbs. of paper was recycled, and 1,250 lbs. of pesticides and fertilizers and 3,235 lbs. of hazardous chemicals were collected through citywide recycling events. A total of 8 volunteer hours were provided, yielding a dollar value of $228.32. An estimated 1,025 UESEP brochures and 1360 flyers were shared with clientele. Posts were made to the ACES website and social media sites to enhance Extension's online presence. Social media analytics revealed significant increases in program reach, impressions, and engagements compared to the previous year. The outputs were as follows: 2915 Facebook Engagements, 72,944 Facebook Reach, 23,973 total page views, 326 Instagram Impressions, 2383 Instagram Engagements, and 2,525 total online video views for UESEP postings.

UESEP outputs helped individuals better understand conservation issues and protect natural resources. Ninety-six percent of the Fall Eco-friendly Fridays Environmental Education Webinar Series participants surveyed (n=81) reported knowledge gains on environmental issues; 90% planned to implement a shared BMP; 90% planned to share what they learned with family and friends; 72% felt they achieved a social expectation of providing a safer home for their family, and 96% felt they achieved an environmental expectation of becoming a better environmental steward.

Post survey results revealed that 89% of past participants had implemented at least one recommended BMP. Over 204 participants were reached through the program in 2021. Of the 2021 Camp Conservation participants (n=52) surveyed, 89% planned to share what they learned within the next six months; 92% achieved the environmental expectation of becoming a better environmental steward; 77% achieved an environmental expectation of saving money in the classroom, and 94% felt that the course increased their knowledge of environmental and STEM topics. In addition, post-delayed results indicated that 32% of returning teachers had shared what they learned in the 2020 series with their students. The Environmental Exploration Virtual Series was offered as five-part weekly series to teach 3rd-5th graders about energy, water, wildlife, and natural resources. Program demographics were as follows: (n=288), Male (34%), Female (66%), White (60%), Black (8%), American Indian (7%), and Other (23%). Of the student participants surveyed, 58% felt the program made them want to protect the environment. Results revealed that the series was most effective at increasing the student's ability to observe (23%), evaluate (20%), and reason (19%) as it relates to the acronym PERFORM.

Program demographics for teachers participating in the English Lend an EAR Storytime Series were as follows: (n=41), Male (0%), Female (100%); White (15%), Black (80%); and Other (5%). Sixty-one percent (61%) of the teachers felt the books supported their STEM learning outcomes; 70% felt the books were helpful for the students' literacy development, and 56% felt the series helped them achieve an expectation of becoming a better environmental steward. Further, 29% of the teachers felt that the students showed a greater interest in exploring nature and the outdoors; 21% agreed that the children expressed greater interest in natural resource topics, and 17% agreed that the children expressed more interest in protecting natural resources after completing the storytime series.

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

UESEP outputs led to positive behavior changes toward natural resource conservation among diverse stakeholders. First, participants gained knowledge on the benefits of reducing, reusing, and recycling. Second, K-8th youth improved their performance skills: [i.e., ability to problem solve, evaluate, reason, focus, observe, research a problem, and measure (PERFORM)]. Third, participants observed an increase in their interest in the outdoors, ecological literacy, and appreciation for the environment. Finally, most participants achieved a social, economic, or environmental expectation due to the program.

Results of an Eco-friendly Fridays on-demand course offered to primarily underrepresented college students revealed that (91%) of participants increased their knowledge on topics like disaster preparedness and climate change. Seventy-nine (79%) planned to implement a practice learned to reduce their ecological footprint, and 91% planned to share what they learned with family and friends [(n=58), Male (19%), Female (81%); White (10%) and Black (90%)].

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

Citizens must develop an awareness of their connection to the natural environment to make better-informed decisions. Children, in particular, need this understanding early on to develop into good environmental stewards as adults. The outputs of UESEP included opportunities for the broader public that accentuated the need for improved stewardship by everyone.

More than 25 STEM books have been shared and over 2200 children reached through the Lend an EAR program; most were underrepresented youth. Of those surveyed [(n=94), Male (49%), Female (51%); White (5%), Black (85%); and Other (9%), Hispanic (13%) and NonHispanic (86%)] forty-four (44%) were 4th graders. Seventy-nine (79%) wanted to read more due to Lend an EAR, 80% felt Lend an EAR increased their knowledge of natural resource topics, 76% agreed that the program made them want to protect the environment. Student comments were as follows: "I love storytime." "I liked everything." "It was fun, and it helped me read better." and "It made me think." Overall the youth fostered an appreciation for natural resources through reading via the English and Bilingual versions of the Lend an EAR Series.

The Team also collaborated across disciplines to attain outcomes with a broader audience. For example, Tornado Preparedness and Chainsaw Safety Workshops offered on-site demonstrations covering an array of chainsaw safety practices and information on disaster evacuation, sheltering, and preparing emergency kits. Similar collaborative events provided forage management, silviculture, and agroforestry best management practices (BMPs) to diverse animal producers. Participants in the At Home Beekeeping Series learned the benefits of pollinators and BMPs for beekeeping. Findings indicated that participants (n=940) would save money using the information they learned in the beekeeping classes. Other collaborative beekeeping efforts included active participation by team members in a 2021 Beekeeping Symposium and a COLOSS Conference.

Benefits are further documented in the Team's acquisition of several awards in 2021; the first "Outstanding Youth Education Program Award" presented by Alabama ANREP, the "Alabama PLT Education Partner of the Year" presented by the Alabama Project Learning Tree Steering Committee, and an Agent's "Partner of the Year" recognition by the RC&D Council.

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.

Notably, the onset of the COVID-19 pandemic resulted in unprecedented challenges. In some ways, it presented new opportunities to advance environmental education, ultimately catalyzing innovations in program delivery. Nonetheless, many issues persist with Covid-19 restrictions confining program delivery, implementation, and evaluation, especially where face-to-face interaction with people and nature is essential. Also, problems with limited internet access, broadband, and the use of technology are enormous challenges.

Program results were disseminated to communities of interest using radio, television, magazines, University bulletins and calendars, and online internet sources (i.e., Facebook, Twitter, Instagram, ACES website, Blogs, etc.). Program impacts were highlighted in the AEA and ACES FWNR newsletters and ACES online success stories. In addition, program impacts were spotlighted in local newscasts and newspapers, state and federal annual reports, and the ACES Urban Difference Report. A scientific article entitled "Assessment of Physicochemical Parameters and Heavy Metals in the Surface Water of North Alabama" was also published in the Journal of Environmental Science and Engineering.

Urban Green
Project Director
Kimberly Holmes
Organization
Alabama A&M University
Accession Number
7002396

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

The Urban landscape and 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.

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 course of 2021, seven REAs conducted workshops, seminars and attended various conferences to educate Alabama urban clientele on the benefits of gardening in limited urban spaces, composting, vermiculture, shrub and tree pruning and maintenance, planting bed irrigation basics, and the options and opportunities available for gardening with limited resources. Total number reached by the Urban Home Grounds, Gardens and Home Pests Programming FY2021 was 97,354; Urban Green FY2019 reached 3,365 individuals through 89 scheduled activities. Urban Green accounted for 53% (n=14,780) of total Urban Home Grounds programming.

Urban Green participants were 83% (n=12,220) adults, 7% (n=1,019) youth, 22% (n=3,250) black, 62% (n=9,141) white, 21% (n=3,092) male, and 69% (n=10,147) female. The percentage of adult participants who improved their knowledge of program concepts were as follows: Irrigation practices (70%), Water Conservation Practices (82%), Composting (86%), Rainwater Harvesting and Uses (88%). The average knowledge of green space use was relatively low (1-3) compared to after the Urban Green programs and demonstrations, very high (4-5). Of the adult participants, 83% agreed that the program encouraged them to adopt green space practices. Resulting impacts: 80% increase in using best management practices.

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

The average knowledge of green space use was relatively low (1-3) compared to after the Urban Green programs and demonstrations, very high (4-5). Among adult participants, 83% agreed that the program encouraged them to adopt green space practices. Resulting impacts: 80% increase in using best management practices.

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

The impact of adopting new hybrid delivery methods during the COVID-19 crisis has allowed our urban programming team to engage a new audience on social media and virtual online delivery. The continued social media presence and online programming has allowed the Urban Home Grounds programming team to reach 61,503 and engage 7,798 new audiences across the state of Alabama and the United States.

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

The limitation of broadband internet access has been a challenge for clientele participation of live virtual programming events. On the other hand, the use asynchonous programming methods has allowed the team to address and overcome this limitation. The team continues to explore new and emerging methods to engage underserved clientele.

On-demand video libraries of recorded program sessions have allowed our programming to engage an audience that is usually engaged with family or work activities. Most of the underserved audiences are single parents and may have two jobs. The introduction of asynchronous programming using on-demand video libraries provides a means to disseminate critical information to underserved clientele.

Alabama A&M University
Accession Number
7002398

Urban Green: STEM in the Gardens

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

Statewide self-quarantine work-from-home and virtual learning orders resulted in a rediscovery of backyard gardens and self-sufficient food production. This prompted area science teacher to explore new methods of engaging youth in STEM utilizing outdoor classrooms and school gardens. AAMU Extension programs transitioned into a new and unexplored virtual world of education delivery, train-the-teacher, and engagement. The Urban Home Grounds team, taking advantage of a captive educator audience, responded with quick innovative programming to address their classroom/school garden needs.

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.

STEM in the Gardens: Teacher Training Workshop. Urban Home Grounds UREAs organized and hosted six sessions (12 presentations) of STEM in the Gardens (Online Statewide: 3-week block @ 2 sessions per week), Participating teachers had the potential to earn 1.5 CEUs per session successfully completed.

225 registrants, and 686 live participants. Survey indicated that participants would save $62 using the management practices they learned in the class. Participating teachers had the potential to earn 1.5 CEUs per session successfully completed.

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

After the COVID-19 crisis of 2019-2020, school science teachers observed an increased interest of gardening and the environment. The utilization of outdoor classrooms and school gardens for STEM teaching was suddenly in demand from teachers. However, several teachers lacked the specialized background and training to manage and sustain a school garden. The STEM in the Gardens, Teacher Training Workshop Series helped address that immediate need for a train-the-trainer program.

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

The adoption of school gardens and outdoor classrooms is not a new idea for school systems. However, the successful utilization of these tools in a STEM curriculum, and continued sustainability of these teacher tools have not been met with success. Teachers that have completed the training workshop have indicated that the specilized training will allow them sucessfully engage their sudents more effectively while also providing an understanding their role as teachers in the sustainability of the school garden/outdoor classroom.

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 limitation of broadband internet access has been a challenge for clientele participation of live virtual programming events.

The impact of adopting new hybrid delivery methods during the COVID?19 crisis has been that our urban programming team engaged a new audience on social media and using online platforms. On?demand video libraries of recorded program sessions have allowed our programming to engage an audience that is usually engaged with family or work activities.

Using ecological approaches to study the effects of dams on aquatic species

Project Director
Dennis DeVries

Organization
Auburn University
Accession Number
1025143

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.

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

Resource managers/fisheries managers, water managers, Federal agency biologists and engineers, policymakers, researchers (both fisheries management and ecological).

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

Our overall goal is to quantify the effects of dams on downstream riverine fishes, including both effects due to variation in flow
and temperature and the potential for fish to pass the dams. Our work will include approaches at three different levels or scales at which dams might exert a biological or ecological effect on a river system. These scales range from the individual organism level to the population level, and our broad research questions related to these scales/levels include:
(1) How do individual fish respond to the barrier provided by a lock and dam structure?
(2) How are fish populations impacted by the presence a lock and dam structure?
(3) How might we be able to mitigate some of these impacts?

Relative to our work with the effects of dams on fishes, we have continued to study how these structures affect fish at both the individual and population levels, as well as how we might be able to mitigate their effects. We have maintained our array of receivers that are spaced approximately 10-20 km apart from the confluence of the Alabama and Tombigbee rivers (RKM0) upstream to Millers Ferry Lock and Dam (RKM218), allowing us to passively track and locate individual tagged fish at a broad spatial scale. Maintenance of these receivers (again, scattered across >200 river km) takes a substantial amount of time, and involves regular relocating and retrieval of the receivers, downloading of the collected data, replacement of the receiver batteries, and placement back in the water at the site. This work has yielded literally millions of data points/locations, which has also taken a substantial amount of time, effort, and computer resources to analyze. We completed our work quantifying the genetics and hard part microchemistry of individuals from two species (paddlefish, smallmouth buffalo) in an effort to determine potential short term (microchemistry) and longer-term (genetics) effects of the dams on fish population ecology, and have begun a follow-up project to use this same approach with smaller and shorter-lived species. A study quantifying the effects of translocation of fish from below Claiborne Lock and Dam to above the dam has been completed and a similar project involving Millers Ferry Lock and Dam (i.e., the next upstream structure) is being initiated. With these two studies, conclusions can be drawn as to whether passage around these structures could lead to fish movement back to the Cahaba River, which is a primary goal for the state relative to fish passagework. We have published one paper (which appeared online) during the reporting period and have 4 others that are currently in manuscript form and in various stages of revision.

Finally, in the Tallapoosa River, we continue to quantify the effects of a hypolimnetic hydropower discharge from Harris Dam on the downstream fish community. This discharge leads to a dramatically increased flow combined with hypolimnetic water temperatures (i.e., cold water in the summer), making it unclear what the ultimate population effects will be. The fieldwork for
this effort has been completed and a final report was submitted to the Alabama Power Company during the reporting period. Additional laboratory work with fish swimming performance and metabolic measures continue. Our results from this work will
ultimately be used to help with decision-making relative to the future operation of this hydropower structure.

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 the project provided:
--mentoring of graduate students
--addition of a postdoctoral fellow to our research project team
--inclusion of research technicians in all aspects of the research project
--inclusion of undergraduate students in the research project

How results have been disseminated to communities of interest:
--We have made numerous presentations of our findings to resource agencies in Alabama, to 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 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 have conducted meetings with other potential funding sources.

Plan during the next reporting period to accomplish the goals:
--We continue to broaden our work to include effects of dams on fishes, and are increasing the focus from being on large migratory riverine fishes to include smaller forms, as well as starting to consider some non-native species.
--We have already scheduled numerous additional presentations to resource agencies and professional scientific societies at the state, regional, and national/international levels, all of which depend on Covid-19 protocols.
--We will continue to prepare and submit additional manuscripts for publication in peer-reviewed scientific journals.
--We continue to explore additional potential funding sources for this and related work, including potential work with The Nature Conservancy and the US Army Corps of Engineers relative to potential fish passage structures being considered for the lowermost two lock-and-dam structures on the Alabama River (which is in the heart of our current field study area).

Theses/Dissertations Published 2021
Horne, L.M. 2021. The effects of temperature and dissolved oxygen on fish respiration determined by enzymatic and organismal techniques. Dissertation, Auburn University, AL. 117+xiii pages.

Journal Articles Published 2021
Bart, R.J., D.R. DeVries, and R.A. Wright. 2021. Change in piscivore growth potential after the introduction of a nonnative prey fish: a bioenergetics analysis. Transactions of the American Fisheries Society 150:175-188 (doi:10.1002/tafs.10276).

Journal Articles Awaiting Publication 2021
Hershey, H.J., D.R. DeVries, R.A. Wright, and D. McKee. in press. Evaluating fish passage and tailrace space use at a low-use low-head lock-and-dam. Transactions of the American Fisheries Society (28 text pages, 4 tables, 10 figures).

Journal Articles Awaiting Publication 2022
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. in press. Stepping up: a U.S. perspective on the ten steps to responsible inland fisheries. Fisheries (33 text pages, 6 tables, 3 figures).

Conference Papers and Other 2020
Bickley, S., L. Kalin, D.R. DeVries, and C. Anderson. 2020. Effects of coastal urbanization on tidal creeks and fringing salt marsh ecosystems along the northern Gulf of Mexico. Bays and Bayous Symposium.

Conference Papers and Other 2021

Hershey, H., D.R. DeVries, R.A. Wright, D. McKee, D. Thomas, and C. Laubach. 2021. Multispecies fish passage and movements in the Alabama River. Annual Meeting of the Alabama Chapter of the American Fisheries Society, Ramer, Alabama.

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 Alabama Chapter of the American Fisheries Society, Ramer,

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 Alabama Chapter of the American Fisheries Society, Ramer, Alabama.

Rotar, C., D.R. DeVries, and R.A. Wright. 2021. Evaluating the effects of three Alabama River dams on fish movements using otolith microchemistry. Annual Meeting of the Alabama Chapter of the American Fisheries Society, Ramer, Alabama.

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 Alabama Chapter of the American Fisheries Society, Ramer, Alabama.

Other Published 2021

DeVries, D.R., R.A. Wright, E. Stell, and E. Lamb. 2021. Using bioenergetics to address the effects of temperature and flow on fishes in the Harris Dam tailrace. Final Report to the Alabama Power Company, Birmingham, Alabama. 302 pages.

Closing Out (end date 09/06/2023)

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.

The focus of this project is to conduct applied research with a focus on broadening the available knowledge base on the longterm impacts of changing water availability as related to net primary productivity (NPP) of forest ecosystems. 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 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 greatest shifts NPP are occurring, 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. Develop long-term, integrated, and multidisciplinary geospatial databases designed to support the research objectives of this study. Over the course of the year data was assessed for land use, and lack of change in forested land use. Hydrological records were assessed for 40+ years of data and overlay watershed with long-term forest land use, sites were selected. Two of the sites, NC and GA, hydrological data have been downloaded and preprocessed. 2. Assess the long-term effect of shifting

variability in water availability on productivity in forest ecosystems and investigate spatial and temporal trends in productivity and feedback loops. Sampling of tree cores at two sites has been completed. A graduate student has been identified and is working on proposed research at a local scale under this objective

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

During the first year, several students both graduate and undergraduate were involved in this project, they all came on during the latter part of the year due to limited on-campus interactions due to Covid. Partnerships with regional state and federal agencies were developed to allow site sampling also facilitated conversations about broader research and determination of results.

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

Limited results are available at this stage, 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.

There are no major changes expected beyond 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 t progressed as fast as expected. The extension would not be more than a year with no extra resources needed.

Promoting Alabama Occupational Worker Safety and Health through Personal Protective Equipment with Emerging Technologies

Project Director
Young A Lee
Organization
Auburn University
Accession Number
1021449

Promoting Alabama Occupational Worker Safety and Health through Personal Protective Equipment with Emerging Technologies

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

This HATCH proposal seeks to apply the Alabama Agricultural Experiment Station (AAES) mission, improving people's lives while promoting the environmentally and socially responsible advancement of Alabama's agricultural, forestry and related industries, to a population of individuals who are committed to serving Alabama, our nation, and the world, specifically occupational workers including healthcare professionals, first responders, and pesticide applicators who work in hazardous and
high-stress environments that may lead to immediate or long-term health consequences.

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 PI especially focuses on the closed-loop system of personal protective equipment (PPE) design and development, use, care, and maintenance with workers in Alabama and their families who may face elevated vulnerability as a result of the lack of PPE maintenance and care. In this work, the closed-loop system is defined as a societal system where products and their components are designed,
manufactured, used, and handled so as to circulate within society for as long as possible, with maximum usability, minimum adverse environmental impacts, minimum waste generation, and with the most efficient use of water, energy and other resources throughout their lifecycles.

Alabama is one of the states that has the most fire deaths per million population in the U.S. and 41% of people with fire risk are
living in rural areas. Citizens in the state are exposed to this risk and the first responders, here firefighters, are the most at risk. Emergency Medical Services are one of the Alabama fire stations' major activities, which require the use of proper PPE when entering into various unexpected hazardous situations. PPE is also critical for healthcare workers (HCWs) as the first line of defense in infection prevention and control in Alabama. Approximately 18 million people in the U.S. are working in the healthcare field, and emerging concern for HCWs' safety and infection prevention is evident. PPE is a critical component of isolation precautions and used widely in healthcare facilities as a part of the strategy to minimize passage of microbes to patients and exposure of HCWs. The state is also known as the 8th largest cotton growing state according to the final 2017 USDA Crop Estimates report. The state grows cotton using a traditional, conventional method which requires a regular pesticide
application. Wearing PPE is important to protect workers or farmers from dangerous chemicals when applying pesticides to the
field. However, many agricultural workers do not wear proper PPE because of a host of socio-cultural barriers. In sum, in the state of Alabama compared with other U.S. states, there are more tendencies toward exposures of occupational workers to hazardous environments. When accounting for the family of these workers, a sizeable portion of the state is directly or indirectly
impacted by these environments.

Therefore, considering the full lifecycle of PPE, the purpose of this HATCH project is to investigate the needs of PPE (e.g., protective clothing, respirator, glove, hat) for Alabama occupational workers in hazardous and high-stress environments in order
to improve the protection, fit, comfort, durability, functionality, and mobility of PPE along with its use, care, and maintenance. Once factors of issue for the workers have been identified, PPE prototypes can be developed with the appropriate selection of fabrics/materials. Design and evaluation of PPE prototypes can then be undertaken to find the best possible solutions. The prototype design will account for differences in Alabama occupational workers' anthropometrics, their socio-cultural barriers, new fabrics available in the market, PPE lifecycle considering its impact on the environment, various activities the workers are involved in, and wearable technologies to improve the health and safety of workers and their families.

The proposed project will have implications for several areas within the textiles and apparel discipline (e.g., apparel design, fiber
and textile sciences, apparel production, product innovation for human health and well-being) and beyond this discipline (e.g.,
environmental sustainability, agricultural and natural resources). All stakeholders within the closed-loop system for occupational
workers' safety and health will ultimately benefit from this project.

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

Target audiences include (a) scientists and students at Auburn University who are interested in personal protective equipment (PPE) design, development, and evaluation and (b) healthcare professionals, one type of occupational worker, who wears PPE in a hazardous and high-stress environment for their safety and protection.

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

The purpose of this HATCH project is to investigate the needs of PPE (e.g., protective clothing, respirator, glove, hat) for Alabama occupational workers in hazardous and high-stress environments in order to improve the protection, fit, comfort, durability, functionality, and mobility of PPE along with its use, care, and maintenance. The proposal focuses on three primary
topics with regard to Alabama occupational workers (e.g., healthcare workers, firefighters, pesticide applicators) and their family lives:
• Proper PPE use, maintenance, and care of occupational workers in a hazardous and high-stress environment for their and their family members' safety and health
• Novel PPE design and development for enhancing the workers' function and movement and protecting them from a hazardous and high-stress environment
• Education and training of PPE use, maintenance, and care: The needs of rural, geographically dispersed occupational workers and their families, and their perceived access to support.

The mission of AAES is rooted in innovations and scientific discoveries as a mechanism to improve the lives of individuals in Alabama, the nation, and the world. This project addresses two AAES priority areas: (a) integrated food and human health systems: focus is on workers' safety and health, toxins, and impact of pesticides on the ecosystem and (b) sustainable ecosystems and renewable resource management: focus is on the closed-loop system of PPE use, care, and maintenance with workers in Alabama and their families who may face elevated vulnerability as a result of the lack of PPE maintenance and care.

The work of this HATCH project consists of three primary objectives: (a) needs assessment for PPE in Alabama; (b) PPE design, development, and evaluation with the application of emerging technologies; and (c) outreach: education and training for Alabama occupational workers and their families through the development of a resource website to collect PPE related research (e.g., PPE use, maintenance, and care) and its closed-loop system practices. This also will provide useful resources for various stakeholders in Alabama, as well as nationwide.

What was accomplished under these goals?
During this review period (Oct. 1, 2020-Sept. 30, 2021), the 2nd round of needs assessment survey was conducted with HCWs focusing on isolation gown, one type of PPE, which will assist in (a) future PPE design, development, and evaluation, and (b) education and training for Alabama healthcare workers (HATCH Project Objective 2). This 2nd round survey was designed by incorporating the 1st round survey results focusing on: (a) examining donning and doffing practices of HCWs' current isolation gown using the CDC's donning and doffing guideline; (b) evaluating the performance of current isolation gown design features including fit, mobility, comfort, donning and doffing, and aesthetic, (c) exploring current maintenance practices of isolation gown among HCWs, and (d) exploring HCWs' interest to incorporate wearable sensors as a part of isolation gown to detect virus transmission. The outcomes of this stage of the study built the foundation to initiate a novel PPE prototype design for HCWs' safety and protection (HATCH Project Objective 2).
In healthcare, a protective gown, one type of personal protective equipment, acts as the first line of defense by blocking the transmission of organisms between HCWs and patients. Despite having vast studies confirming the role of its safety and protection, there are still concerns about HCWs' self-contamination during the donning and doffing process of protective gowns. Previous studies demonstrated that the limitation within the gown design is one of the main reasons for HCWs' exposure to the unsafety environment; for instance, difficulty in removing isolation gowns around the neck increases the chance of self-contamination during the doffing process. Thus, the purpose of this study was to identify key design features of isolation gowns which should be improved for ensuring HCWs' safety and protection (HATCH Project Objective 1 Needs assessment for PPE).

An online survey was conducted with a convenience sample of U.S. healthcare professionals, directly interacting with patients and having experiences of wearing protective gowns (isolation gown and coverall) in healthcare. The survey consisted of four sections: (a) demographics; (b) current usages of protective gown including the donning and doffing sequence; (c) closeended questions about HCWs' opinions about current protective gown in terms of fit, mobility, comfort, donning and doffing, and aesthetic; and (d) open-ended questions on its design challenges and suggestions for their safety and protection. A total of 153 valid responses (76.5**%** female and 23.5**%** male) were used for data analysis. Participants' ages ranged from 23 to 74 years old with a mean age of 43. The majority was White/European American (73.2**%**), followed by Asian (11.1**%**), African American (9.8**%**), Hispanic American/Latino (5.2**%**), and others (0.7**%**). Of the participants, 64.7**%** were classified as professional nurses including registered nurses, licensed practical nurses, and nurse practitioners. The rest included medical doctors (8.5**%**), physio-therapist (7.8**%**), physician assistants (7.2**%**), occupational therapists (5.9**%**), and physician (5.9**%**). Their work experiences in healthcare ranged from 1 to 50 years with a mean experience of 18 years.
The results show that isolation gown was the most commonly used protective gown in healthcare. Among the features of fit, mobility, comfort, donning and doffing, and aesthetic, HCWs were not concerned much about its aesthetic. For HCWs, utilitarian features (e.g., donning and doffing, fit and sizing, comfort) that directly influence their work performance are much important for its design consideration. The findings present the need of improving the gown's design features including closures at the back, sleeve length, gown length, and around the neck for better body protection. HCWs shared their design suggestions more toward the way to provide better body coverage from the external hazard environment by wearing isolation gowns. They emphasized improving its back closure area to easily fasten and untie drawstrings, which are closely related to the donning and doffing performance. Further research is needed to examine the relationship between these design features and the donning and doffing performance. The findings of this study showcase the interrelationships among isolation gown properties, HCWs' task requirements, environmental conditions, and their characteristics, and how comfort can be achieved while interacting among HCWs, isolation gown, and the environment for their better work performance and safety. Despite having some limitations, this study provides critical insights for a novel isolation gown design and development by considering
more of its utilitarian, task-related features to ensure HCWs' safety and health.

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.

Under the COVID-19 pandemic, public awareness for the proper use and maintenance of PPE has been significantly increased. As a member of the translational science group in the College of Human Sciences (CHS) and a scientist who currently conducts research on PPE for HCWs, I was involved in developing two short videos featuring the proper use and maintenance of masks, one type of PPE, working with the CHS communication team. These educational videos have been disseminated to the University campus and public in early 2021 as a proper training kit, which is available through http://humsci.auburn.edu/research/cahs.php?

With the findings from the two rounds of the needs assessment survey (HATCH Project Objective 1), our team is transitioning to the next stage of this study on PPE Design, Development, and Evaluation (Objective 2). This part includes the following steps: (a) identification of new design features by examining current isolation gown's comfort, function, and movement using the needs assessment survey data; (b) identification and development of wearable sensors that capture PPE's hazard contamination level; (c) development of new PPE prototypes embedding wearable sensors, considering easy donning and doffing; and (d) PPE prototype evaluation through users' wear testing and their acceptability questionnaires. This part of the project is continuously collaborating with researchers in Nursing and Kinesiology. We will primarily focus on (a) through (c) within Objective 2.

Journal Articles Published 2021
Lee, Y. A., Salahuddin, M., Gibson-Young, L., & Oliver, G. D. (2021). Assessing personal protective equipment needs for healthcare workers. Health Science Reports, 4(3), e370. https://doi.org/10.1002/hsr2.370

Conference Papers and Published 2021
Lee, Y. A., & Li, Y. (June 18, 2021). The second skin in the new normal. The 112th American Association of Family & Consumer Sciences Annual Conference & Expo: Apparel, Textiles & Design Juried Showcase and Exhibition [virtual].

Gibson-Young, L., Lee, Y. A., Salahuddin, M., & Oliver, G. (2021). Needs assessment of current personal protective equipment for healthcare workers, 2021 American Association of Nurse Practitioners (AANP) National Conference, June 15-20, 2021.

Conference Papers and Awaiting Publication 2021
Lee, Y. A. & Salahuddin, M. (2021). Analyzing healthcare workers' current isolation gown for their safety and protection, International Textile and Apparel Association Virtual Annual Conference in November 3-6, 2021.

Conference Papers and Published 2020
Lee, Y. A., Salahuddin, M., Gibson-Young, L., & Oliver, G. D. (2020). Assessment of current personal protective equipment for healthcare workers, International Textile and Apparel Association Annual Conference Proceedings 77(1). https://doi.org/10.31274/itaa.11861

Audio or Video
Under the COVID-19 outbreak, public awareness for the proper use and maintenance of PPE has been significantly increased. As a member of the translational science group in the College of Human Sciences (CHS) and a scientist who currently conducts research on PPE for HCWs, I was involved in developing two short videos featuring the proper use and maintenance of masks, one type of PPE, working with the CHS communication team. These educational videos have been disseminated to the University campus and public in early 2021 as a training kit.
Two video clips can be viewed in Consortium for Advancing Transitional Human Sciences website (http://humsci.auburn.edu/research/cahs.php) and C@HS Research Video on CHS Mask (https://www.youtube.com/watch?v=ISXx4PgUr8Y&t=2s)and Wearing and Covering Mask (https://www.youtube.com/watch?v=-zICOv_8yOo&t=18s)

Closing Out (end date 09/06/2023)

Estimating the Carbon Budgets for Major Agricultural Crops in Alabama

Project Director
Monday Mbila
Organization
Alabama A&M University

Accession Number
1020869

Estimating the Carbon Budgets for Major Agricultural Crops in Alabama

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

This proposal uses a multi-method approach to addresses the carbon cycling patterns of agronomic cropping patterns in Alabama. Net ecosystem exchange (NEE) is a measurement of how much carbon is entering and leaving the ecosystem. For agricultural ecosystems, NEE measurement has been used to characterize the fluxes in photosynthetic uptake of CO2 by plants and ecosystem release of CO2 by plant respiration and decomposition. The goal of the proposed project is to estimate the carbon balance for selected major agronomic crops by evaluating above-crop canopy C, biomass C, below-canopy C, and soil C.

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/Measurements:

We conducted experiments and analyzed data on carbon budget in a soybean field with LI-8100A instrument.

The LI-8100A Soil CO2 measurement was carried out by installing soil collars and placing the LI-8100A on top of the collars to form a closed chamber to measure CO2.

For both Till and No-Till plots, CO2 flux was measured at between rows (BR) and within rows (WR) of the soybean stand.

The soil CO2 chamber recording of the soil CO2-flux was performed for 1.5 minutes (including 25 s dead-band time, 50 s measurement time and 15 s purge time).

The soil CO2 emission measurements were made throughout soybean growing season (July 1 - October 17) in 2019, at weekly intervals during early-to mid-morning on measurement days.

Data collected by the LI-8100A was output to a spreadsheet for data analysis.

Results:

Soil-surface CO2 flux ranged from 0.91-5.8 µmol m−2 s−1 at Tilled plots and ranged from 0.85-4.59 µmol m−2 s−1 at No-Till plots during the entire growing season.

CO2 flux was higher at the Tilled soybean plot than at the No-Till plot during the growing season which indicates that No-Tilled soil sequestrated more carbon in the soil.

Tillage affects soil CO2 fluxes by exposing and breaking down soil organic matter releasing CO2.

In both the Tilled and No-Till plots, soil CO2 flux was higher within rows (WR) than between rows (BR).

Higher soil CO2 flux of within row measurement may be due to closer proximity to the rhizosphere within rows that leads to increased autotrophic respiration and heterotrophic respiration.

This study shows how cropping systems (tillage practices and row positions of croplands affect soil CO2, efflux and how these differences affect the NEE and overall carbon balance.

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

The target audience of this work is climate scientists whose knowledge in climate research is being enhanced by providing information to support ongoing studies for identifying the sources and sinks for atmospheric CO2 of ecosystems. It is also providing scientists information needed to bridge the gap between CO2 dynamic of agricultural ecosystems and that of other

less dynamic systems. The audience includes farmers that need this information to make judgements about CO2 dynamics of agronomic systems and practices, understand extent of climatic change due to agronomic practices, and make informed decisions to improve soil health, fertility, and yield.

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

Soil surface CO2 emission data from this study represents a major contribution to a wider objective of estimating the total C-budget of agronomic ecosystems that also include soil organic matter-C, vegetation biomass-C as well as above canopy-C.

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 postdoc and the graduate student on this project are working together and being supervised and trained in this research. Additionally, the student is being inspired to present technical papers at professional meetings and symposia, as well as jointly author manuscripts from the research/learning experiences. From these students' contact, we expect to attract more students into our program at AAMU. This will help to increase the ethnic, racial and gender diversity in the environmental science profession. So the project has provided the opportunity for training of participants of the project.

Results from the project has been presented at local and national scientific meetings. Findings were presented at the 2022 1890 Association of Research Directors meeting in Atlanta, GA. Findings were also presented at the Alabama A&M University STEM Day events. There are plans to do more dissemination of results from this project to communities of interest, especially scientists in climate research by publishing technical papers/manuscripts from the research in scientific journals.

Development of a spatially-explicit model to improve longleaf regeneration

Project Director
Zhaofei Fan
Organization
Auburn University
Accession Number
1019465

Integrating Forest Inventory Analysis/Forest Health Monitoring data with GIS/RS data to develop a geospatial modeling framework for risk mapping of nonnative invasive plants i

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

Biological invasion has become an increasing threat to productivity and ecosystem services provided from native forestland, wetland, pasture, prairie, and savanna. A major aspect of effective invasive plant control is reducing spread and reinvasion following control.

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 proposes an integrated, multiscale approach to study the invasion mechanisms of major invasive plants and factors influencing spread and successful establishment. The study consists of three components: 1) Identify and quantify ecological and socio-economic factors contributing to the invasion and spread of invasive plants in southern forestland; 2) Develop context (ecosystem)-dependent geospatial models to understand the invasion mechanisms of invasive plants; and 3) Assess the invasibility and resilience of invaded forest ecosystems. Findings of this study will provide useful information for the development of effective and practical control and mitigation approaches of invasive plants for land and resource managers.

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

Foresters, biologists, fire specialists, land and resource managers, and stakeholders in the broad natural resources/forestry areas. Our research results/findings will especially benefit researchers and land/resource managers working on invasive species management and longleaf pine restoration and management.

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

Goal 1. Identify and quantify geographical, ecological and socio-economic factors that affect the invasion, establishment and spread of major invasive plants in southern forests

We have completed mapping one important invasive tree species- Chinese tallow (*Triadica sebifera*) across the southern forestland for the past two years by using the USDA Forest Service's Forest Inventory and Analysis (FIA) data. We developed three sub-regional models to quantify the relationship between propagule pressure and annual invasion probability for Chinese tallow monitoring and risk analysis. We have published six publications focusing on the spread mechanisms of invasive tallows at a stand, landscape, and regional level for managing Chinese tallows and restoring native ecosystems.

Goal 2. Develop hierarchical geospatial models to predict and map the extent and spread rate of invasive plants

We tested the geospatial models of major invasive plants across six hierarchical levels (hydrological units: HUC4, HUC6, HUC8, HUC10, and HUC12) to predict the spread of invasive plants in the state of Alabama. These models identified significant risk factors related to invasion processes, including seed dispersal, seed germination, seedling recruitment, and the establishment. They provided a hierarchical decision-making tool to land and resource managers. Based on these results, a dissertation chapter has been completed.

Goal 3. Assess the invisibility and resilience of forest ecosystems/landscapes under alternative management scenarios

Using repeatedly measured FIA plot data, we monitored the change of presence probability and cover percentage of Chinese tallows between two consecutive inventory cycles. The product of presence probability and cover percentage was used as a proxy of invasion severity to quantify the invasibility of seven major forest ecosystems in the southern United States. Based on the product change of presence probability and cover percentage, the resilience of different forest ecosystems was assessed. The research findings (Nepal et al. 2021) have been published in Forest Science.

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

One master's student (Nannan Cheng) completed her master's thesis during this project period, and one Ph.D. candidate (Sunil Nepal) completed one chapter of his dissertation. One postdoctoral research associate (Shaoyang Yang) has been trained in this research, published one journal article (Yang et al. 2021), and submitted another for peer review.

In January of 2022, we have signed an agreement with the Grand Bay National Wildlife Refuge and Mississippi Sandhill Crane National Wildlife Refuge to conduct a new research that tests the impact of prescribed fire on the longevity of the seed bank of invasive Chinese tallow based on our previous research findings. Our results (publications, posters) have been shared with land and resource managers in an online workshop organized by the Grand Bay National Wildlife Refuge in 2021. Meanwhile, our publications have been submitted to the land managers and fire specialists from the Grand Bay National Wildlife Refuge and Mississippi Sandhill Crane National Wildlife Refuge, where the research was conducted.

During the next report period, we will evaluate how prescribed fire and land management will affect the risk of tallow invasion. A new graduate student has been recruited for working on this topic. We have completed the installation of field experiments and data collection and analysis will be conducted following the fire treatment. The student will completed his thesis by the end of the next reporting period. The student will present his research findings in the future conferences and workshops.

Journal Articles Published 2021

*Nepal, S., W. K. Moser, Z. Fan. 2021. Spatiotemporal invasion severity of Chinese tallow (*Triadica sebifera*) and invasibility of forest types in the Southern USA forestlands. Forest Science. https://doi.org/10.1093/forsci/fxab019

Fan, Z., A. Song, L. Dong, H. D. Alexander, S. Yang, N. Cheng, and J. L. Pitchford. 2021. Fire effects on post-invasion spread of Chinese tallow (*Triadica sebifera*) in wet pine flatwood ecosystems in the southeastern United States. Forest Ecology and Management 500, 119658 https://doi.org/10.1016/j.foreco.2021.119658

*S. Yang, M. A. Spetich, and Z. Fan. 2021. Spatiotemporal dynamics and risk factors of oak decline and mortality in the Ozark Highlands of Missouri, USA: A comprehensive analysis of repeatedly measured FIA data. Forest Ecology and Management 502, 119745 https://doi.org/10.1016/j.foreco.2021.119745

Conference Papers Accepted 2021

Thapa, N., L. Narine, Z. Fan, and S. Yang. 2021. Impact assessment and investigation of accuracy for mapping invasive species using airborne lidar and multispectral aerial imagery. The 13th Southern Forestry and Natural Resources GIS Conference, Athens, GA. December 6-7, 2021.

Data and Research Material

We installed 150+ permanent plots for long term forest resource monitoring in southern Alabama and Mississippi. These plots have been measured periodically (every three to five years). Both plot/tree locations and attributes were stored in MS-Excel and/or R data formats for analyses.

Changes/Problems

During this reporting period (2020-2021), we installed 214 permanent quadrats (1x 1 m) in a heavily infested management unit in the Mississippi Sandhill Crane National Wildlife Refuge to monitor invasive species (Chinese tallow).

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.

Specific project objectives are to: (1) Quantify the effect of soil physical and chemical properties and infiltrating water chemical properties on pollutants transport processes and (2) simulate the fate and transport processes of pollutants. The long-term goals of this project are to advance our knowledge on fundamental nutrient transport processes and provide a valuable datasets to support decision support tools.

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

Research results were presented at various national and international conferences and were shared with the researchers, and soil and water conservation personnel.

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

Major goals of the project:
The long-term goal of this project is to improve our understanding of pollutants (e.g., nutrients, metals) transport processes in agricultural landscapes as a function of different watershed characteristics.
1. Quantify the effect of soil physical and chemical properties and infiltrating water chemical properties on pollutants transport processes
2. Simulate the fate and transport processes of pollutants.

Rainfall simulation experiments were conducted to determine the influence of manure application on pollutant leaching in pastures. Results show that loss of contaminants can be significant in leachate. Application of broiler litter enhanced loss of contaminants in leachate. The HYDRUS-1D model was used to describe the transport of nutrients in the soil columns. Preliminary results indicate that soil macropores could facilitate the transport of contaminants via subsurface flow pathways.

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.

The results have been disseminated to the communities of interest in the following:
• Kumar, H., Srivastava, P., Lamba, J., Ortiz, B.V., Morata, G., and Takhellambam, B.S. 2021. Time stability in soil moisture in irrigated agricultural field. Alabama Water Resource Conference, Orange Beach Alabama, September 7-10.
• Kumar, H., Srivastava, P., Lamba, J., Ortiz, B.V., Takhellambam, B.S., Way, T.R., and Morata, G. 2021. Phosphorus variability in delineated irrigation management zones in the crop field. Alabama Water Resource Conference, Orange Beach Alabama, September 7-10.
• Takhellambam B S, P Srivastava, J Lamba, R McGehee, H Kumar, & D Tian. 2021. Stochastic generation of 15-minute precipitation for water resource modeling under climate change over Southeastern United States. Alabama Water Resources Conference; Sept 8-10; AL, USA
• Takhellambam B S, P Srivastava, J Lamba, R McGehee, H Kumar, & D Tian. 2021. Effect of climate change on rainfall erosivity in Southeastern, United States. Oral presented at Alabama Water Resources Conference; Sept 8-10; AL, USA
• Malhotra, K., J. Lamba, T. Way, S. Budhathoki, and P. Srivastava. 2021. Influence of manure application and soil physicochemical properties on phosphorus leaching in pastures. Alabama Water Resources Conference and Symposium, Orange Beach, Alabama, September 8-10, 2021.
• Budhathoki., S., J. Lamba, P. Srivastava, C. Williams, F. Arriaga, and K. G. Karthikeyan. 2021. Quantification of 3-D Soil Macropore Characteristics in Different Land Uses Using X-ray Computed Tomography. Alabama Water Resources Conference and Symposium, Orange Beach, Alabama, September 8-10, 2021

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.

Journal Articles Published 2021
Singh, R., R. Prasad, B. Guertal, K. Balkcom and J. Lamba. 2021. Effects of Broiler Litter Application Rate and Time on Corn Yield and Environmental Nitrogen Loss. Agronomy Journal. doi:https://doi.org/10.1002/agj2.20944.

Kumar, K., P. Srivastava, B. V. Ortiz, G. Morata, B. S. Takhellambam, J. Lamba, and L. Bondesan. 2021. Field-Scale Spatial and Temporal Soil Water Variability in Irrigated Croplands. Transactions of the ASABE: 64 (4), 1277-1294. doi: 10.13031/trans.14335

Bhatta, A, R. Prasad, D. Chakraborty, J.N. Shaw, J. Lamba, E. Brantley, H.A. Torbert. 2021. Mehlich 3 as a Generic Soil Test Extractant for Environmental Phosphorus Risk Assessment Across Alabama Soil Regions. Agrosyst Geosci Environ. 2021; 4:e20187. https://doi.org/10.1002/agg2.20187

Closing Out (end date 09/06/2023)

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.

This project focuses on understanding the biology and physiology of urban arthropod pests that live in and around our homes. The structural pest control industry in the U.S. generated an estimated $8.6 billion in total service revenue in 2017 and is increasing at approximately 5% per year. In addition, homeowners purchase >$2 billion in over the counter insecticide products to control household pests.

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 this project is to develop and implement safe, biologically based, and cost-effective integrated pest management (IPM) systems for control of urban arthropod pests. Specific objectives are to: 1) Determine the effects of insecticides, relative humidity, and temperature on the energetics, respiration patterns, and water relations of urban arthropod pests, 2) Develop and validate laboratory bioassays that estimate field efficacy of insecticides, repellents, and environmental modifications used to control urban arthropod pests, and 3) Develop integrated control systems for urban arthropod pests. This project addresses the goals of the USDA-NIFA and the National IPM Roadmap, and will identify low input IPM tactics that will reduce pesticide use in and around homes, reduce human health risks, and minimize adverse effects of toxic conventional insecticides on urban ecosystems and wildlife.

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

The target audience for this research includes both undergraduate and graduate students (for classroom lectures and discussions), pest management professionals (PMPs), and other professional urban entomologists, insect physiologists, and insect behaviorists.

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

The overall goal of this project is to identify key aspects of the biology, physiology, and ecology of urban arthropod pests that can be used to develop IPM systems for their management. Specific objectives include 1) determining the effects of insecticides, relative humidity, and temperature on the energetics, respiration patterns, and water relations of urban arthropod pests, 2) developing and validating laboratory bioassays that estimate field efficacy of insecticides, repellents, and environmental modifications used to control urban arthropod pests, and 3) developing integrated control systems for urban arthropod pests.

Effective control of domestic and peridomestic cockroaches requires integrated approaches that emphasize concurrent use of chemicals with alternative control tactics. An integrated pest management (IPM) approach is particularly justified in environments where satisfactory cockroach control cannot be achieved due to multiple factors including the development of insecticide aversion and resistance in some cockroach species, and poor sanitation or structural issues that foster infestations. While a flurry of research efforts have been devoted to studying alternative tactics for cockroach control, only a few of them have been evaluated in the context of IPM programs. This review focuses on examining studies on alternative tactics that are proven efficacious, economical, and logistically feasible for their inclusion in IPM programs for important domestic and peridomestic cockroaches in the USA. Management programs that educate the public on cockroach biology, behavior, and the importance of sanitation; use of traps to monitor infestation levels; apply targeted low impact insecticides such as baits, have demonstrated a greater success for effective and sustainable control of cockroaches when compared to an insecticide-only approach. Incorporation of other alternative control methods into IPM programs will require more applied research that validates their use in real-world scenarios and demonstrates their cost-effectiveness.

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 from this research have been presented to pest management professionals as well as undergraduate and graduate students. Results have also been presented to pest management professionals at the Alabama Pest Control Association winter and summer meetings and at meetings of the Entomological Society of America. Continued studies on the toxicity and repellency of conventional insecticides and essential oil products are planned for the next reporting period.

Book Chapters Published 2021

Appel, A. G. 2021. Biology, nutrition, and physiology. pp. 53-74. In Changlu Wang, Chow-Yang Lee, and Michael K. Rust (eds.), Biology and Management of the German Cockroach. CSIRO Publishing, Australia.

Appel, A. G. and M. K. Rust. 2021. German cockroach management using baits. pp. 213-230. In Changlu Wang, ChowYang Lee, and Michael K. Rust (eds.), Biology and Management of the German Cockroach. CSIRO Publishing, Australia.

Journal Articles Published 2021

Gondhalekar, A. D., A. G. Appel, G. M. Thomas, and A. Romero. 2021. A Review of Alternative Management Tactics Employed for the Control of Various Cockroach Species (Order: Blattodea) in the USA. Insects. 12(6), 550; https://doi.org/10.3390/insects12060550

Journal Articles Accepted 2021

Appel, A.G., B. N. Dingha, M. J. Eva, and L. E. N. Jackai. 2021. Toxicity, repellency, and laboratory performance of consumer bait products for German cockroach (Blattodea: Ectobiidae) management. Florida Entomologist.

Closing Out (end date 09/06/2023)

Assessment of the role of land processes in improving hydroclimate predictability at seasonal to decadal (S2D) time scales

Project Director
Sanjiv Kumar
Organization
Auburn University
Accession Number
1016464

Assessment of the role of land processes in improving hydroclimate predictability at seasonal to decadal (S2D) time scales

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

The overarching goal of this research proposal is to enhance our understanding of land processes that can potentially contribute to climate (precipitation and temperature) and hydrological (soil moisture and runoff) predictability, referred as hydroclimate predictability, hereafter at S2D time scales and access their impacts on a range of climate variability phenomena including long-term drought, soil moisture predictability for agricultural sector, and decadal climate variability.

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 hypothesize that sub-surface soil moisture memory that ranges from several months to a year or longer can be seasonally tapped into by soil moisture, vegetation, and coupled land-atmosphere processes to provide soil moisture anomaly
re-emergence that can lengthen the predictability time scales beyond a season. We seek to better understand these processes using ground-truth observations, suitably designed rainfall exclusion experiment at a tree stand in the Southeastern United States, and hierarchy of climate model simulations that is aimed at isolating the role of individual processes in soil moisture anomaly re-emergence. We propose to employ state-of-the-art climate and earth system model (CESM), advanced land surface
and hydrology models (CLM), other available soil moisture data and climate modeling experiments, and analytical

approaches
that include Linear Inverse Modeling (LIM). This research likely to enhance our capability to predict long-term droughts in the United States and elsewhere.

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

Target Audience:

1) Climate Scientists
2) Regional drought planning agency and stakeholders
3) Graduate and undergraduate students

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

The overarching goal of this research proposal is to enhance our understanding of land processes that can potentially contribute to climate (precipitation and temperature) and hydrological (soil moisture and runoff) predictability, referred as hydroclimate predictability, hereafter at S2D time scales and access their impacts on a range of climate variability phenomena including long-term drought, soil moisture predictability for agricultural sector, and decadal climate variability.

What was accomplished under this goal?
Advances in long lead-time soil moisture prediction will greatly augment the ongoing drought early warning efforts for agriculture and natural ecosystems. Our new study (Esit et al., 2021) examined longer-term (months to years) climate processes from the decadal prediction experiments of Community Earth System Modeling (CESM). This study provided new insights into the interplay between atmospheric (precipitation) and land-surface processes on those timescales that can boost
the predictability (i.e., ability to forecast successfully) of soil moisture on both seasonal and multi-year timescales. A critical finding from the study is that the predictability for soil moisture on seasonal periods is three times greater than that for precipitation. Regionally, the study finds that this potential soil moisture predictability is higher for the central and western United States, mainly on longer lead times that could span multiple years.

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?
1. Ph.D. training for two graduate students at Auburn University: PD Kumar supervises two Ph.D. students in the Earth System Science program at Auburn University. Ph.D. Student Yanan Duan is working on downscaling of soil moisture forecast. Another Ph.D. student Montasir Maruf is working on high-resolution climate modeling for an improved soil moisture forecast.

2. Data science training for Deep Leaning model development: PD Kumar advise a data scientist Mr. Sathish Akula at Auburn University. Mr. Akula is developing a deep learning model for forecast improvement using National Water Model data.

3. PD Kumar participated in the national level meeting and conferences: American Geophysical Union (AGU) Fall meeting 2021, American Meteorological Society (AMS) Annual meeting 2021, and CESM Annual Workshop 2021. These meetings provided the opportunity to share results with the scientific community and learn about the latest science in soil moisture forecasting.

4. PD Kumar served as the lead convener for the AGU 2021 Fall meeting Global Environmental Change session titled: "Drivers and Mechanism of Terrestrial Water Cycle changes at global and regional scales."

How have the results been disseminated to communities of interest?
1. Peer-reviewed publication: We published three pre-reviewed publications.
2. Results from the study were presented at AGU, AMS, and CESM Annual meetings.
3. Our publication on soil moisture forecasting (Esit et al., 2021) received local and regional media attention, e.g., YellowHammer News, Auburn University news, and University of Colorado news.

What do you plan to do during the next reporting period to accomplish the goals?
1. Assessement of soil moisture forecast skill in the seasonal to multi-year large ensemble forecast.
2. Develop high-resolution soil moisture data assimilation system.

Journal Articles Published 2021
Esit, M., Kumar, S., Pandey, A., Lawrence, D. M., Rangwala, I., & Yeager, S. (2021). Seasonal to multi-year soil moisture drought forecasting. npj Climate and Atmospheric Science, 4(1), 1-8.

Duan, Y., Kumar, S., & Kinter, J. L. (2021). Evaluation of Long?term Temperature Trend and Variability in CMIP6 Multimodel Ensemble. Geophysical Research Letters, e2021GL093227.

Sutton, C., Kumar, S., Lee, M. K., & Davis, E. (2021). Human imprint of water withdrawals in the wet environment: A case study of declining groundwater in Georgia, USA. Journal of Hydrology: Regional Studies, 35, 100813.

Conference Papers and Published 2021
Kumar, S., Dewes, C., & Newman, M. Changing drought and pluvial risks in North America linked to mean-state changes in ENSO and soil moisture. In AGU Fall Meeting 2021. AGU.

Duan, Y., & Kumar, S. (2021, December). Assessemnt of internal climate variability in CESM2-LE and its comparsion with mutli-model CMIP6 large ensemble. In AGU Fall Meeting 2021. AGU.

Joseph, J., Kumar, S., & Merwade, V. (2021, December). Effect of Linear and Non-linear Detrending on Streamflow Data. In AGU Fall Meeting 2021. AGU.

Singh, A., Kumar, S., & Chen, L. (2021, December). Increased uncertainty in land-use change impacts on near-surface air temperature due to global warming in CMIP6-LUMIP experiments. In AGU Fall Meeting 2021. AGU.

Anderson, C. J., Dunning, K., Dwivedi, P., Hall, R., Kalin, L., Kumar, S., ... & Morse, W. (2021, December). A humannatural framework for assessing, forecasting and managing watersheds for coastal resiliency along the Gulf of Mexico. In

Changes/Problems
1) COVID-related remote working and learning environment, as well as personnel challenges made things slower.

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

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

As the need for productivity in the agricultural industry increases and urban areas continue to expand, landscapes become altered to provide the necessary food, fiber and shelter for our growing population. These landscape changes transfer materials
from the terrestrial environment to aquatic ecosystems. These materials can induce ecological change in water systems and reduce ecosystem services, recreation, fisheries and other economically valuable characteristics. However, most monitoring programs began in the past 20 years leaving a knowledge gap of material inputs and ecological change prior to monitoring efforts.

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 Hatch project will apply paleolimnological tools to sediment cores collected from Alabama reservoirs, lakes and bays with two primary research objectives addressed. First, determine the input of materials (nutrients, metals, organic matter)
into Alabama aquatic ecosystems throughout the last 150 years linking land use change with sediment measurements. Second, reconstruct primary producer community (algae, cyanobacteria) responses to the material inputs over time. The primary outcome from these objectives is to provide lake managers, stakeholders and landowners tools to improve water quality
and effectively manage these systems for future use.

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

As with all of our research, our target audience still focuses on managers, stakeholders, scientists and students studying aquatic ecosystems. We have continued to share our results with stakeholders through meetings and workshops, school groups through classroom visits, and managers through direct meetings and visits to share data. Given that we are supplying unknown information to systems where historic information does not exist, the general acceptance of our data is usually met with excitment. We plan to continue to aid in the sustainbility of these systems as our data expands and our inferrences strengthen. Our outreach has expanded this year through partnerships with the Joseph Jones Ecological Research Center and the Water and Planning Center at Albany State University.

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

Alabama and other areas of the SE USA have dramatically altered landscapes to meet the food and fiber needs of the region and the nation. As a result, the materials produced from these perturbations have deposited in the array of aquatic systems in Alabama and impacted local ecosystem quality. This Hatch project seeks to identify the delivery and storage of materials (nutrients, metals, and other molecules) in Alabama aquatic ecosystems as well as the ecosystem responses from the aquatic environments. In addition, multivariate statistics will be incorporated to identify the drivers of ecosystem change. Outcomes will be delivered to managers and stakeholders to improve aquatic ecosystem function and terrestrial ecosystem management. The objectives of this Hatch project are: 1) Reconstruct the storage and movement of nutrients in the shared reservoirs of Alabama and Georgia along the Chattahoochee River from West Point Lake to Lake Eufala relating biogeochemical dynamics to land-use, hydrological flows and the invasive species, Hydrilla verticillata, 2) Identify the origin of sediment deposition into Lake Tuscaloosa relating aquatic ecosystem change to homestead construction, historic coal mining practices and local erosion from land clearance, 3) Relate nutrient inputs, reservoir connectivity and hydrological flows to the eutrophication of the three reservoir system of the Coosa River in central Alabama, 4) Reconstruct prescribed fire and wildfire in the Conecuh National Forest and relate those events to changes in the deposition of nutrients and algal community structure in the natural lakes within the forest, 5) Connect historic water quality and eutrophication of the coastal bays of Alabama with industrial and landscape inputs from pre-human disturbance to the modern era.

What was accomplished under these goals?

Objective 1: We have completed the project for the Chattahoochee and have published the work in Science of the Total Environment. This article shows that P retention is greatest in the initial reservoir of a reservoir string while N retention is more related to residence time in the reservoir. These differences alter nutrient stoichiometry throughout the basin not normally accounted for in reservoir models. In addition, graduate student, Ben Webster, has been delivering talks on the project to multiple conferences where we have engaged stakeholders. As a result of this research, Ben Webster is not adding the Flint River basin to the project and we are on the planning committee for a conference in 2022 focused on water quality in the ACF River Basin. Also, material from this objective is being used for additional projects in generating dating models for reservoir systems.
Objective 2: Has not occurred due to lack of funding.
Objective 3:Tristan Orndorff graduated with her Master's degree in the summer of 2021. Her thesis shows that the limnological history of Lay Lake has remained constant for the entire 100 year existence of the reservoir. This result demonstrates a lack of ontogeny typically projected for reservoirs and suggests that the management and placement of the system might be the determining ecological driver rather than time. For Weiss Lake, the transport and deposition of nutrients and heavy metals did not coincide with agricultural or urban land use, but seemed to follow the historic channel prior to reservoir genesis.
Objective 4: We are still working on publishing these findings and were not successful in achieving additional funding although

grants were submitted to the Alabama Center for Excellence and the National Science Foundation to continue this work. Findings show a dramatic increase of P delivery associated with burning that caused increases in cyanobacteria in the lake systems. However, historic sediment records show that the cyanobacteria decreased around 1990. We are currently attempting to identify with land managers the changes in management practices in a prescribed fire during this time.
Objective 5: No new developments on this project except that a new Master's Student, Jessica Curl, is beginning her Master's Research on this project.

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?
Objective 1) This project has served as the PhD graduate work of Ben Webster who graduated with his Master's in 2019.
Objective 2) Nothing to report
Objective 3) This project served as the Master's project for Tristan Orndorff, who graduated in Summer 2021 as well as undergraduates Susan Iott and Lucy Trosper.
Objective 4) These cores served as the Master's project for Melissa Dehart, who graduated with her Master's in 2021
Objective 5) This project has served as the Master's project of Alex Metz who graduated in 2019

How have the results been disseminated to communities of interest?
Objective 1:Portions of this project have been presented at the Alabama Water Resources Conference, the Georgia Water Resources Conference and the Geological Society of American Conference. Also, the Webster et al. 2021 publication is part of this objective.
Objective 2:Nothing to report.
Objective 3:Portions of this project have been presented at the Alabama Water Resources Conference and the Geological Society of American Conference.
Objective 4:Portions of this project have been presented as the keynote address to the British Phycological Society.
Objective 5:Nothing to report

What do you plan to do during the next reporting period to accomplish the goals?
Objective 1: Ben Webster is adding the Flint River basin to this project so that both basins that join together will be studied. Also, this incorporates an agricultural watershed into the project. Likewise, climate precipitation data are being incorporated to
investigate if nutrient transport and phytoplankton ecology are explained by rainfall changes in the river basin.
Objective 2: No expectations.
Objective 3: We hope to publish our findings in a peer-reviewed journal. Also, given our work on this river system, we are collaborating with other labs at Auburn to investigate the transport and deposition of PFAS and PFOA in these systems.
Objective 4: We hope to publish the findings in a peer-reviewed journal and submit an NSF proposal to continue this work.
Objective 5: We will begin continuing this work on Weeks Bay and Choctahatchee Bay in 2022.

Journal Articles Published 2021
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

Atkinson, C.L., H.M. Halvorson, K.A. Keuhn, M. Winebarger, A. Hamid, M.N. Waters. 2021. Filter-feeders have differential bottom-up impacts on green and brown food webs. Oecologia 195 (1): 187-198.

Conference Papers and Other 2021
Webster, B.C., M.N. Waters, S.W. Golladay. 2021. Variation of Nutrient Deposition and Transport Between Agricultural and Urban Watershed Through Time. Alabama Water Resources Conference. Orange Beach, AL.

Eggert, C., M.N. Waters, S.W. Golladay. 2021. Geographically Isolated Wetlands in the southeastern United States serve to store and process nutrients from agricultural watersheds. Alabama Water Resources Conference. Orange Beach, AL.

Webster, B.C., M.N. Waters, S.W. Golladay. 2021. A Paleolimnological Reconstruction of Nutrient Transport Throughout the Reservoirs of the Chattahoochee River Through Time, Georgia Water Resources Conference. Online.

Webster, B.C., M.N. Waters, S.W. Golladay. 2021. Sediment transport and stochiometric transformations in a 6-Reservoir sequence on the Chattahoochee River utilizing paleolimnological records. GSA Southeastern Conference,

M.N. Waters. 2021. Ancient HABs: Comparing historic and modern cyanobacteria dynamics in the tropics and subtropics over the last 5000 years. British Phycological Society Annual Meeting. Remote.

Product Type
The database for the Webster et al. 2021 article is freely available and includes a multi-decadal history of nutrient transport for the entire Chattahoochee River Basin.

Changes/Problems
No problems other than funding for Objective 2 never materialized.

Hydro-climate analytics and modeling for sustainable water and agronomic management

Project Director
Di Tian
Organization
Auburn University
Accession Number
1012578

Hydro-climate analytics and modeling for sustainable water and agronomic management

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

Weather variability and extreme climate events posed great risks on water supplies and crop productions. Hydro-climate monitoring and forecasting will provide important information for agricultural and water resource communities to effectively manage weather and climate risks.

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 this project, an innovative agro-hydro-meteorological monitoring and forecasting system will be developed based on integrated emerging datasets and forecasts with computer simulation models using quantitative systems methods. The agrometeorological monitoring and forecasting system will be delivered to end users to support scientific-based objective decision making. Given the nature of datasets and models used in this project, the methods being developed will be highly transferable and potentially beneficial to different regions over the nation, and even across the globe.

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

Target audiences for this progress report include:
(1) Undergraduate, graduate student, and postdoc research in the lab (1 undergraduate student, 5 graduate students, and 1 Postdoc);
(2) Graduate students through formal classroom teaching (Course: Agroclimatology);
(3) Extention specialists in Alabama and other neighboring states
(4) Research findings were presented by the students and postdoc at national and international meetings.

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

Objective 1: During the reporting period, we have accomplished three major tasks related to this objective, focusing on subseasonal precipitation forecast, monthly inflow forecast, and climate model downscaling.
For the first task, we assessed multimodel subseasonal precipitation forecasts (SPFs) from eight subseasonal experiments (SubX) models over the contiguous United States (CONUS) and explored the generalized extreme value distribution (GEV)-based ensemble model output statistics (EMOS) framework for postprocessing multimodel ensemble SPF. The results showed that the SubX SPF skill varied by location and season, and the skill was relatively high in the western coastal region, north-central region, and Florida peninsula. The GEV-based EMOS approach dramatically improved the MME subseasonal precipitation forecast skill at long lead times, by at least 20%. Regarding the relative contributions of the individual SubX model to the predictive skill, the NCEP model was given the highest weight at the shortest lead time, but the weight

decreased dramatically with the increase in lead time, while the CESM, EMC, NCEP, and GMAO models were given approximately equal weights for lead weeks 2-4. The presence of active MJO conditions notably increased the forecast skill in the north-central region during weeks 3-4, while the ENSO phases influenced the skill mostly in the southern regions. This work has been published in the Journal of Hydrometeorology.

The second task focuses on bias correcting and downscaling climate model simulations. In this study, we use 20 state-of-theart coupled general circulation models (GCMs) daily mean, maximum and minimum temperature (Tmean, Tmax and Tmin) from the Coupled Model Intercomparison Project phase 6 (CMIP6), and comprehensively evaluate a new Super Resolution Deep Residual Network (SRDRN) deep learning model, comparing with a conventional quantile delta mapping (QDM) approach, for climate downscaling and bias correction. The SRDRN model sequentially stacks 20 GCMs with single or multiple input-output channels, so that the biases can be efficiently removed based on the relative relations among different GCMs against observations, and the intervariable dependences can be retained for multivariate bias correction. It corrects biases in spatial dependences by deeply extracting spatial features and making adjustments for daily simulations according to observations. For univariate SRDRN, it considerably reduced larger biases of Tmean in space, time, as well as extremes compared to QDM. For multivariate SRDRN, it reduced greater biases of Tmax and Tmin but also reproduced intervariable dependences of the observations (Tmax > Tmin), where QDM showed unrealistic artifacts (Tmax < Tmin). Additional studies on the deep learning-based approach may bring climate model bias correction and downscaling to the next level. This work has been submitted for publication in Climate Dynamics.

For the third task, we developed and evaluated a hybrid framework for reservoir inflow forecast. This framework is unprecedented, which integrates new quasi-globally available observation-, satellite-, or model-based datasets using machine learning models to forecast inflow at the local scale. The performance was evaluated in the humid Alabama-Coosa-Tallapoosa river basin and the Navajo reservoir in the arid Upper Colorado River Basin (UCRB). The results showed that for the Harris reservoir, the BMA combining five models with antecedent inflow and satellite-based hydrologic information as model inputs provided the best performance. For the Navajo reservoir, the gradient boosting machine model with all variables combined as input showed the best performance. Satellite-based soil moisture and evaporation consistently showed significant contributions to the inflow forecast. Benefits from climate indices and FLOR reforecast varied by locations, with more benefits coming from climate indices than FLOR potential evaporation reforecast at the Navajo reservoir in UCRB. Given the global coverage of the model inputs, our approach can be potentially applicable to improve reservoir inflow forecasts in different regions of the world. This work has been published in Stochastic Environmental Research and Risk Assessment.

Objective 2: During the reporting period, we have accomplished two major tasks related to this objective, focusing on assessing climate and cover crop impacts on water use efficiency, and estimating leaf wetness duration using deep learning. For the first task, we explored how changing climate and its extremes in the 20th and 21st-century influence system water use efficiency (sWUE) of a corn-soybean cropping rotation in a humid sub-tropic environment, and how much can cover crops mitigate these impacts. Different from the traditional yield-focused water use efficiency (WUE), sWUE addresses both production and environmental quality goals by considering grain yields and all major system water losses (evapotranspiration, runoff, and drainage). A calibrated crop simulation model, Root Zone Water Quality Model version 2 (RZWQM2), was applied to simulate grain yields and all major system water losses. The model was forced by daily climate data from in situ observations during 1956-2015 and 10 downscaled and bias-corrected General Circulation Model (GCMs) projections under the representative concentration pathways (RCP) 4.5 and 8.5 scenarios during 2020-2079. The results showed that, under the historical baseline and the future RCP4.5 and RCP8.5 scenarios, due to the growth of cover crops, the sWUE for corn and soybean were significantly improved. Soil evaporation, as the largest source of water loss from the cropping system, was significantly decreased. The annual drainage was decreased. With the incorporation of wheat cover crops, the correlations of temperature or precipitation extremes with grain yields and major water losses were mostly decreased, suggesting that growing cover crop is an effective means to mitigate the impact of climate extremes on the sWUE of corn-soybean cropping. This work has been published in Agricultural Water Management.

For the second task, we developed and evaluated a novel framework based on machine learning techniques with climate reanalysis data to estimate leaf wetness. We compared the Random Forest, kernelized Support Vector Machine, Feedforward Neural Network, and Classification and Regression Tree models with hourly surface and near-surface meteorological inputs from state-of-the-art climate reanalysis datasets, ERA5 and MERRA2. The models were trained and cross-validated using three-year hourly leaf wetness observation data at nine agricultural sites in Alabama and six sites in California. The models were intercompared with each other and with a simple model based on observed relative humidity (with 90% used as a threshold, referred as RH). The results indicated that the machine learning models based on ERA5 showed better performance than the MERRA2-based models as well as the observation-based RH model. In particular, the ERA5-based Random Forest model showed the best performance for estimating hourly leaf wetness occurrence and daily LWD than the other approaches. In comparison with the RH method, the ERA5-driven Random Forest model showed at least 2 h smaller

MAE and RMSE than the other methods for estimating daily LWD, suggesting a great potential for practical applications. The results also showed that the ERA5-driven Random Forest model accurately predicted the leaf wetness occurrence in space (with 70 to 87% accuracy), suggesting a potential for large-scale crop disease surveillance and climate impact assessment, particularly for regions with sparse in situ observation data. This work has been published in Agricultural and Forest Meteorology.

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 also provided training and professional development for four graduate students in crop, soil, and environmental sciences or earth system science, one undergraduate in environmental science major, and one postdoc research professional. They have been working with the project director to perform research tasks such as literature review, data retrieval, data processing and analysis, modeling, conference presentations, and preparing manuscripts. Thro ugh these activities, they have increased their skill and knowledge in climate science, hydrology, and environmental data science.

The newly generated information and methods have been shared with science communities through publications in peerreviewed
journal articles and presentations in conferences, workshops, and symposiums.

During the next reporting period, we will continue the efforts to improve our understanding and predictions of climate means, extreme events, and impacts on water, agriculture, and ecosystems at different scales. Such understanding and predictions will inform climate adaptations and resilience actions. First, we will improve evapotranspiration estimates using ECOSTRESS and Harmonized Landsat Sentinel-2 satellite imagery. Second, we will continue improving SRDRN approach for downscaling and bias correcting general circulation models' (GCMs) simulations. Projected and historical changes of climate extreme indicators will also be assessed using the downscaled and bias-corrected GCMs simulations. Third, we will continue analyzing the changes in twelve agroclimatic indices, which are indicators of agriculture-significant climate condition, for four globally important staple crops: maize, rice, soybean, and wheat, as well as contributions of these indices to the changes in crop failures over global crop production regions from 1981 to 2016. Fourth, we will assess the spatial and temporal variability of flash droughts in the continental United States (CONUS) and their impacts from sea surface temperatures. Our findings will expect to improve the current subseasonal to seasonal (S2S) prediction and drought management in the United States. Fifth, we will investigate the role of climate, CO2, and technological advances on the trend of crop yields.

Journal Articles Published 2021
Asadi, P., and D. Tian. 2021. Estimating leaf wetness duration with machine learning and climate reanalysis data. Agricultural and Forest Meteorology, 307, p.108548.

Li, Yizhuo, D. Tian, G. Feng, W. Yang, L. Feng. 2021. Climate change and cover crop effects on water use efficiency of a corn-soybean rotation system. Agricultural Water Management, 255, p.107042

Saminathan, S., H. Medina, S. Mitra, and D. Tian. 2021. Improving short to medium range GEFS precipitation forecast in India. Journal of Hydrology, p.126431

Wang, F., D. Tian, L. Lowe, L. Kalin, and J. Lehrter. 2021. Deep learning for daily precipitation and temperature downscaling. Water Resources Research, 57, e2020WR029308

Tian, D., X. He, P. Srivastava, and L. Kalin. 2021. A hybrid framework for forecasting monthly reservoir inflow based on machine learning techniques with dynamic climate forecasts, satellite-based data, and climate phenomenon information. Stochastic Environmental Research and Risk Assessment, pp.1-23.

Medina, H., D. Tian, and A. Abebe. 2021. On optimizing a MODIS-based framework for in-season corn yield forecast. International Journal of Applied Earth Observation and Geoinformatics, 95, p.102258.

Conference Papers and Accepted 2021
Lesinger, K.*, D. Tian. Flash drought spatiotemporal variability in the continental United States and its prediction from Atlantic and Pacific sea surface temperatures. 2021 GSA Southeastern Section Meeting, 1–2 April 2021. Auburn, Alabama (online)

Schillerberg, T.*, D. Tian. Changes of agroclimatic conditions and associated crop failures over global crop lands. 2021 GSA Southeastern Section Meeting, 1–2 April 2021. Auburn, Alabama (online)

Singh, T. B., P. Srivastava, J. Lamba, R. McGehee, H. Kumar, D. Tian. Stochastic generation of 15-minute precipitation for water resource modeling under climate change over Southeastern United States. Alabama Water Resources Conference, September 8-10, 2021, Gulf Shore, AL.

Lesinger, K.*, D. Tian. Spatial temporal variability of flash drought in the continental United States. Alabama Water Resources Conference, September 8-10, 2021, Gulf Shore, AL.

Rashid, T.*, D. Tian. Predicting Field-scale Daily Evapotranspiration Using Multi-Source Spaceborne Remote Sensing Imagery and Deep Learning. Alabama Water Resources Conference, September 8-10, 2021, Gulf Shore, AL.

Wang, F.*, D. Tian. On deep learning bias correction for GCMs daily temperature outputs. The 3rd NOAA Workshop on Leveraging AI in Environmental Sciences, September 13–17, 2021, Boulder, Colorado & Virtual

Zhen, X., W. Huo, D. Tian, Q. Zhang, A. Sanz-Saez, C. Chen, W. D. Batchelor. County-Level Calibration Strategy to Evaluate Peanut Irrigation Water Use Under Different Climate Change Scenarios. 2021 ASA, CSSA, SSSA International Annual Meeting, November 7-10, Salt Lake City, UT.

Karki, R., P. Srivastava, L. Kalin, and D. Tian. Application of SWAT-MODFLOW for evaluating the impacts of climate change on the surface- and groundwater resources of the lower Apalachicola Chattahoochee Flint River Basin, USA. 2021 AGU Fall Meeting, 13-17 December 2021, New Orleans, LA and online.

Henrique, H, L. Kalin, J. Lehrter, D. Tian, and L. Lowe, A watershed modeling framework to assess the impacts of environmental changes in the Mobile Bay, Alabama. 2021 AGU Fall Meeting, 13-17 December 2021, New Orleans, LA and online.

Schillerberg, T.*, D. Tian. Global Crop Failure and Associated Changes in Agroclimate Conditions. 2021 AGU Fall Meeting, 13-17 December 2021, New Orleans, LA and online.

Harris, M.*, D. Tian. Understanding Heat-Related Morbidity across the Rural-Urban Spectrum: A Comparison of Two States in the United States Sun Belt. 2021 AGU Fall Meeting, 13-17 December 2021, New Orleans, LA and online.

Wang, F.*, Di Tian. Bias Correction of Multi-model GCMs Daily Temperature based on Deep Learning. 2021 AGU Fall Meeting, 13-17 December 2021, New Orleans, LA and online.

Lesinger, K.*, Di Tian. Spatiotemporal Variability of Flash Drought in the Continental United States. 2021 AGU Fall Meeting, 13-17 December 2021, New Orleans, LA and online.

Journal Articles Submitted 2022
Wang, F.*, D. Tian. Submitted. On deep learning-based bias correction and downscaling of multiple climate models. Climate Dynamics

Improving water and energy conservation on Alabama broiler farms
Project Director
Jeremiah Davis
Organization
Auburn University
Accession Number
1012577

Improving water and energy conservation on Alabama broiler farms

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

In the Southeastern US, broiler chicken growers have experienced continual increases for the cost of construction and for the costs of energy and water resources. There are two major sources of water usage on a broiler farm; bird consumption and the evaporative cooling system. Energy can be partitioned into fuel (diesel for the backup generator, propane or natural gas for heating) and electricity (fans for ventilation, lights, feed motors, etc.). Decreasing costs associated with energy and water inputs
is the major driver for increasing profitability for the broiler grower.

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.

Efforts during the current project period will be spent on the improvement of both energy and water conservation within the commercial broiler housing system. Water conservation will be addressed by examining best management practices for the evaporative cooling system and quantifying water storage needs to utilize rainwater harvesting. Energy conservation will be addressed by examining alternative ventilation schemes that are
comparable to the traditional negative pressure tunnel ventilation method.

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

Twenty-five (16 undergraduate and 9 graduate) biosystems and poultry science students participated in lectures and labs in our University course. Six undergraduates from the College of Agriculture participated in the NPTC Research and Extension Experience for Undergraduates (NPTC REEU) during the 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. Five graduate students participated in research efforts.

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

The goal of this project is to improve the profitability of Alabama broiler growers through increased water and energy conservation during the operation of commercial broiler farms. Specific objectives include:
1. Evaluate broiler house equipment systems and rainwater harvesting storage technologies to improve water conservation
2. Evaluate broiler house equipment systems and ventilation schemes to improve energy conservation

What was accomplished under these goals?
Two journal articles were published. Multiple training events were hosted with industry professionals. Data was gathered across several projects that will be summarized in the next report.

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.

As part of NPTC activities, we developed content and trained industry professionals. Data from research projects are incorporated into outreach activities. As mentioned, twenty-five (16 undergraduate and 9 graduate) biosystems and poultry science students participated in lectures and labs in our University course. Six undergraduates from the College of Agriculture participated in the NPTC Research and Extension Experience for Undergraduates (NPTC REEU) during the 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. Five graduate students participated in research efforts. We have several manuscripts to publish and new projects beginning.

Journal Articles Published 2021
Stoeckel, J.A., M. Szoka, H.A. Abdelrahman, J.D. Davis, D.M. Blersch, and B.S. Helms. 2021. Crayfish chimneys as burrow ventilation structures. J. Crustacean Bio. 41(3): 1-9. https://doi.org/10.1093/jcbiol/ruab045

Linhoss, J.E., J.L. Purswell, and J.D. Davis. 2021. Evaluating radiant heater performance using chick thermal preference and spatial modeling. Appl. Engr. in Ag. 37(3): 447-454. doi: 10.13031/aea.14466

Conference Papers and Published 2021
Davis, J.D. 2021. Effects of the housing environment on necrotic enteritis. Poult. Sci. 100 (E-suppl. 1): 234.

Other Published 2021

J.D. Davis, J.C. Campbell, D. Miller, K.G. Griggs, M. S. Rueda, C.M. Edge. 2021. NPTC Tools of the Trade: Testing a Motor Capacitor. ANR-2783. Alabama Cooperative Extension System.

A. Burgett, J.D. Davis, J.C. Campbell, J.L. Purswell, K.G. Griggs, C. Smith. M. S. Rueda, C.M. Edge. 2021. NPTC Tools of the Trade: smoke tracing to identify air infiltration leaks. ANR-2822. Alabama Cooperative Extension System.

E.A. Johnson, J.D. Davis, J.C. Campbell, J.L. Purswell, K.G. Griggs, C. Smith. M. S. Rueda, C.M. Edge. 2021. NPTC Tools of the Trade: measuring water flow rate. ANR-2827. Alabama Cooperative Extension System.

J.C. Campbell, J.D. Davis, K.G. Griggs, C. Smith. M. S. Rueda, C.M. Edge. 2021. NPTC Tools of the Trade: checking fan pulley alignment. ANR-2834. Alabama Cooperative Extension System.

B. Arnold, J.D. Davis, J.C. Campbell, J.L. Purswell, K.G. Griggs, C. Smith. M. S. Rueda, C.M. Edge. 2021. NPTC Tools of the Trade: checking for gas leaks. ANR-2835. Alabama Cooperative Extension System.

K.G. Griggs, J.D. Davis, J.C. Campbell, O. Fasina, R. Bradford, J. Johnson. 2021. Do your valves and hose bibs restrict water capacity? ANR-2721. Alabama Cooperative Extension System.

J.D. Davis, J.C. Campbell, D. Miller, K.G. Griggs, M. Rueda, and C.M. Edge. 2021. Start and run capacitors for electric motors. ANR-2784. Alabama Cooperative Extension System.

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

Yield, Insurance, and Adaptation: A Research Program Focusing on Agricultural Production in Alabama and the Southeast

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

Climate's impact on crop yield and crop insurance's impact on agricultural production have attracted much attention. Several projects in the CRIS retrieval system aim to address issues related with climate change, crop yields, and crop insurance. However, the proposed project differs from the existing projects in the specific research questions, geographical regions considered, data to be analyzed, and methodology to be used.

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 proposed project complements or extends the existing projects to deepen the understanding on climate's impact on agricultural production, the potential of farmers' adaptation, and crop insurance's impact as a major risk management tool. Specifically, we propose (1) to understand how climatic variability affects crop yields and quantify farmers' adaptation potential with a focus on Alabama and the Southeastern United States; (2)
to investigate the determinants of farmers' insurance demand as a risk management tool and a tool to adapt to climate change;
(3) to explore the effects of crop insurance on technology innovation and adoption; and (4) to examine crop insurance' impacts
on agricultural productivity and farmers' welfare in Alabama and in the Southeast. Outcomes of this objective will be of important
policy implications. They will contribute to the current body of literature about crop insurance's impacts on agricultural production

and hence contribute to the optimal design of the crop insurance program. The research results should also inform farmers' and
potential investors' decisions regarding the adaptation options and crop insurance contract choice.

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

The objectives of this proposed project are (1) to understand how climatic variability affects crop yields and quantify farmers' adaptation potential with a focus on Alabama and the Southeastern United States; (2) to investigate the determinants of farmers' insurance demand as a risk management tool and a tool to adapt to climate change; (3) to explore the effects of crop insurance on technology innovation and adoption; and (4) to examine crop insurance' impacts on agricultural productivity and
farmers' welfare in Alabama and in the Southeast.

Ruiqing Miao presented "Impact of changes in Title II of the 2018 Farm Bill on the Acreage and Environmental Benefits of Conservation Reserve Program" at Program in Environmental and Resource Economics (pERE) Weekly Seminar, Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign. May 3, 2021. About 28 researchers and students from the University of Illinois at Urbana-Champaign attended the presentation.

Ruiqing Miao presented a poster, "Maladaptation of U.S. Corn and Soybean Yields to a Changing Climate," at Auburn Research Faculty Symposium, January 29, 2021, Auburn, AL. The audience was Auburn University faculty members and graduate students.

Ruiqing Miao presented "Time-Varying Adaptation of U.S. Corn and Soybean Yields to a Changing Climate" in the Applied Microeconomics Seminar, Department of Economics (Auburn University, November 4, 2020, Auburn) and in the Department of Agricultural Economics and Rural Sociology (Auburn University, October 26, 2020, Auburn). In total, about 50 Auburn
University researchers and graduate students attended the presentations.

Brian Cornish presented "Impact of changes in Title II of the 2018 Farm Bill on the Acreage and Environmental Benefits of Conservation Reserve Program" at Agricultural & Applied Economics Association (AAEA) Annual Meeting, August 1-3, 2021, Austin, Texas. The audience was researchers and graduate students in the field of agricultural economics.

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

Obj. (1) to understand how climatic variability affects crop yields and quantify farmers' adaptation potential with a focus on Alabama and the Southeastern United States. During the reporting period, we published two papers studying the relationship between climate variability and crop yields. The first is entitled "Distributional and Temporal Heterogeneity in the Climate Change Effects on U.S. Agriculture". The second is entitled "Maladaptation of U.S. Corn and Soybean Yields to a Changing Climate." We also started a new working paper entitled "Agricultural Adaptation to Climate Change across Space: The Case of U.S. Agriculture over 1958-2019." In this paper, we account for space heterogeneity in examining the adaptation of U.S. agriculture to climate change. We allow the adaptation and responsiveness of crop yield to climate variables to vary across space, thereby taking into account potential neighborhood influences on farmers' adaptation strategy.
Obj. (2) to investigate the determinants of farmers' insurance demand as a risk management tool and a tool to adapt to climate change. Nothing to report during this period.
Obj. (3) to explore the effects of crop insurance on technology innovation and adoption. Nothing to report during this period.
Obj. (4) to examine crop insurance' impacts on agricultural productivity and farmers' welfare in Alabama and in the Southeast. We started a new project to study the impact of the federal crop insurance program on agricultural production efficiency and welfare, which will shed light on how crop insurance may affect efficiency of the input use (land, labor, and capital) in the contiguous US.

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.

Ph.D. students Prasenjit Ghosh, Jingfang Zhang, and Brian Cornish, as well as undergraduate students Lindsey Wesse, Roshell Rosales Aguilar, and Seth Ingram in the Department of Agricultural Economics and Rural Sociology at Auburn University, worked on constructing datasets, conducting economic analysis, and writing journal articles.

We presented the results of research at the 2021 Agricultural & Applied Economics Association (AAEA), various seminar or workshop series at Auburn University and University of Illinois at Urbana-Champaign.

We will try to have the current working papers published during the next reporting period and will expand our research to examine how technology innovation and adoption will affect farmers' adaptation to climate change and the sustainability of US
agriculture.

Products
Journal Articles Published 2021
Cornish, Brian*, Ruiqing Miao, and Madhu Khanna. forthcoming. “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. doi: http://doi.org/10.1002/aepp.13185

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

Yu, Chengzheng*, Ruiqing Miao, and Madhu Khanna. 2021. “Maladaptation of U.S. Corn and Soybeans to a Changing Climate.” Scientific Reports. doi: https://doi.org/10.1038/s41598-021-91192-5

Journal Articles Accepted 2021
Khanna, Madhu and Ruiqing Miao. forthcoming. “Inducing the Adoption of Emerging Technologies for Sustainable Intensification of Food and Renewable Energy Production: Insights from Applied Economics” Australian Journal of Agricultural and Resource Economics. doi: https://doi.org/10.1111/1467-8489.12461

Journal Articles Published 2020
Malikov, Emir, Ruiqing Miao, and Jingfang Zhang*. 2020. “Distributional and Temporal Heterogeneity in the Climate Change Effects on U.S. Agriculture.” Journal of Environmental Economics and Management 104:1-10. doi: https://doi.org/10.1016/j.jeem.2020.102386

Closing Out (end date 09/06/2023)

Effects of tillage and residue managements on soil microbial community, carbon dioxide effluxes and soil physical properties in a biofuel sorghum feedstock

Project Director
Qunying Yuan
Organization
Alabama A&M University
Accession Number
1011635

Effects of tillage and residue managements on soil microbial community, carbon dioxide effluxes and soil physical properties in a biofuel sorghum feedstock

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

In this research proposal, we aim to address the NIFA priority challenge areas of **Sustainable Bioenergy** and **Climate Change** by generating knowledge of soil health for a biomass sorghum feedstock production system under climate mitigation managements. Sorghum has been identified as an ideal bioenergy crop candidate in Southeast US for many years because of its high biomass (plant material) yield, drought tolerance, adaptability to diverse growing conditions and low fertilizer requirements. Soil acting as the nexus of climate, water and ecosystems, soil health needs to be urgently evaluated for sustainability of this widespread biofuel crop production system. Reduced tillage and crop residue return have been demonstrated as effective climate change mitigation practices in sustainable agriculture in that they can sequester carbon (C), reduce greenhouse gas (GHG) emissions and enhance water storage. Currently, limited information exists regarding the impacts of crop/soil managements for sorghum production system on soil health indicators. Such information is lacking for

the in Southeast US specifically as it relates to climate- and soil type-specific soil health evaluation. Therefore, the **overall objective of the proposed research to determine the effects of tillage and residue removal rate on soil health for the biomass sorghum production system in Southeast US region**.

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 examined the effects of row position and growth stages on soil carbon dioxide (CO_2) emissions, and the effects of different tillage treatments and residue removal rates on the temporal and spatial dynamics of the soil microbial community, soil physical properties, and soil CO_2 emissions.

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

The results of the proposed project will contribute to the evaluation of environmental soil health arising from climate change mitigation technologies and help to establish a fundamental basis for facilitating the development of biomass sorghum production system.

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

The results of this study will be used to inform soil and crop management decisions for sorghum cropping systems to ensure sustainable sorghum production systems, specifically in a climate-soil-specific manner in the southeastern US. Further, the results will offer new insights for future alternatives concerning the tradeoffs in optimizing production with soil health indicators.

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 problmes encountered during this period.

We have published a manuscript summarizing our findings on soil CO_2 emissions based on the data collected in 2017 and 2018. And we are preparing a manuscript “The effects of residue and tillage on soil CO_2 emission in a sorghum field” based on the data collected in 2019 and 2020. We have also obtained the sequencing results of selected soil properties and microbial communities in a time series of several sampling time points previous years of this field. Data analysis for the selected soil properties suggested a significant change in some soil properties with the production of sorghum; manuscript is in prep.

Critical Issue

Sustainable Energy

BIOMASS CONVERSION INTO BIOFUELS AND HIGH-VALUE ADDED PRODUCTS

Project Director
Sushil Adhikari
Organization
Auburn University
Accession Number
1021649

BIOMASS CONVERSION INTO BIOFUELS AND HIGH-VALUE ADDED PRODUCTS

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

Our society is facing unprecedented challenges such as increasing uncertainty about global energy production and resources, high and fluctuating price of petroleum products, and growing scientific evidence that atmospheric carbon dioxide is among the
most important contributors to extreme weathers and climate change. Therefore, it is critical to increase the renewable energy
supply, and at the same time reduce worldwide greenhouse gas (GHG) emissions. These concerns have motivated researchers for long-term approaches to producing fuels, lubricants, materials and chemicals from biomass.

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 U.S. has a potential to provide over 1 billion dry tons of biomass annually. Forest and agricultural residues are the major biomass types but algae and sub-urban/urban wastes are also available for producing biofuels and biomaterials. Adhikari's group has been focused on
producing biofuels from terrestrial and aquatic biomass using thermochemical approaches for last 11 years. For the next five years, Adhikari's group will focus on creating both biofuels and biomaterials from terrestrial biomass, sub-urban/urban wastes
and algal biomass.

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

During this period, the target audiences were mainly undergraduate, graduate students, and the scientific community interested in bioenergy and biofuels production and utilizing waste biomass and biochar that was produced from the thermochemical conversion process. The group also interacted with several companies working on bioenergy and waste utilization, where the research findings were highlighted. The results were shared through peer-reviewed journal articles and by presenting at two national meetings.

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

The long-term goal of this project is to develop biobased fuels and value-added products. For the year 2021, the team focused on producing biofuels and bioproducts from municipal sludge, algae, carinata (non-food oil seed crop). The team also focused on utilizing biochar for removing phenolics from the aqueous phase of hydrothermal liquefaction process.

Biolubricants from vegetable oils:
The present research and development for lubricant production from vegetable oils rely on traditional (trans)esterification, etherification, and/or chemical modifications of triglycerides and free fatty acids (FFAs). However, the final products suffer from at least one of the following: poor low-temperature characteristics, low oxidation stability, low viscosity index, or poor solubility of additives. Our study presents a novel approach to produce biolubricants (BL) from the reaction of waste cooking oil (WCO) and cyclic oxygenated hydrocarbons (COHCs) (cyclopentanone, cyclopentanol, anisole, and 2-methylfuran) via a four-step pathway: hydrolysis, dehydration/ketonization, Friedel−Crafts (FC) acylation/alkylation, and hydrotreatment. Such reactions were successfully demonstrated using model compounds (oleic acid and stearic acid) and actual WCO feedstock. The process resulted in the production of novel BLs that were consisted of molecules with several mutual properties: (1) long and linear hydrocarbon chains, (2) low to zero unsaturation, (3) minimal branching, (4) naphthenic rings and cyclic structures, and (5) polar molecules. We showed that such BLs can be synthesized with pour-point, kinematic viscosity (at 40 °C), viscosity index, and Noack volatility of −12 °C, 47.5 cP, 186, and 17 wt %, respectively.

Biofuels from carinata oil:
In this work, we present the production of jet and diesel range hydrocarbons from non-edible hexane-extracted Brassica carinata oil. The influence of four heterogeneous catalysts (two noble metal catalysts: Pd/C and Ru/C, and two transition metal catalysts: Ni/C and Ni/SiO2-Al2O3) was investigated at 400 °C. The catalysts were characterized using XRD, Raman spectroscopy, TEM, SEM, TGA, TG-TPR, and BET specific surface area and pore size analyzer. The upgrading experiments consisted of three different approaches: 1) single-step cracking (1-C), 2) single-step simultaneous cracking, and hydrotreatment (1-CH), and 3) a two-step process of cracking followed by hydrotreatment (2-CH). Reaction products were characterized using different instruments and metrics: GC-FID, GC-MS, simulated distillation, CHNS-O elemental analyzer, viscometer, higher heating value (HHV), and total acid number (TAN). The 2-CH process produced the highest amounts of desired hydrocarbons. The highest liquid yield of 81% with HHV of 47 MJ/kg was obtained with the use of Ni/SiO2-Al2O3 catalyst. All catalysts appeared to be regenerable after partial deactivation. Model compound studies were performed using erucic acid that accounted for about 40% of carinata oil FFA (free fatty acid) profile. Reaction pathways were proposed according to the chemical analysis of the products.

Biocrude from sludge:
In this study, ethylene and nitrogen(inert) reaction environments were applied into the hydrothermal liquefaction (HTL) process of municipal sewage sludge with red mud catalyst to evaluate the effects on biocrude and other byproducts. Red mud in three oxidation states was used: red mud calcined at 575 °C (CRM), reduced at 500 °C (RRM500), and 700 °C (RRM700). The RRM500 lowered the acidity by 14%; whereas, the RRM700 minimized the viscosity by 47% comparing to non-catalyticinert
biocrude samples. The ethylene ambience successfully maximized the biocrude yield by 41.6 wt% without any catalyst. The viscosity of the biocrudes produced under ethylene environment showed lower differences compared to nitrogen environment. The RRM500-ethylene reaction efficiently reduced the nitrogen content in the biocrude by 14%. These results suggested that the ethylene atmosphere has the potential for improved biocrude production during catalytic HTL treatment.

Energy recovery from the aqueous phase:
Hydrothermal liquefaction is a promising method to convert municipal sludge into an energy-dense fuel. The inevitable byproduct
aqueous phase is rich in complex organics, which has the potential for energy and nutrient recovery and can be treated by anaerobic digestion to produce methane. However, toxic compounds such as ammonia and phenolics present would inhibit the function of micro-organisms. This study investigated the influence of ammonia and phenolics removal on anaerobic digestion. The results showed that the treated aqueous
phase resulted in up to 225 ml CH4/g COD. The highest methane production was obtained in the culture with both ammonia and phenolics removal at pH 7.0, which was about 90% higher than only ammonia removal and seven times higher than only phenolics removal. The microbial community analysis results showed that these two treatments could increase microbial diversity and upregulate the relative abundance of methanogens.

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 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.

Our focus is on producing biofuels and chemicals from biomass, agricultural wastes, and food wastes. We will continue exploring hydrothermal liquefaction of biomass and food waste for the production of liquid fuels and upgrading for transportation fuels. The work will focus on understanding the effect of process parameters, reaction mechanisms, and the role of heterogeneous catalysts on biocrude upgradability. Additionally, we have identified a handful of bio-char-based catalysts for the production of biofuels from Carinata oil and our initial results show encouraging data for hydrogen treatment of biocrude produced from liquefaction oil. We will continue to explore reaction mechanisms associated with those catalysts and test those catalysts for other feedstocks such as algae oil, municipal sludge, and waste cooking oil. Further, we will explore biobased resins produced from pyrolysis process for additive manufacturing.

Journal Articles Published 2021

Sanjita Wasti, Eldon Triggs, Ramsis Farag, Maria Auad, Sushil Adhikari, Dilpreet Bajwa, Mi Li, Arthur J Ragauskas. 2021. Influence of plasticizers on thermal and mechanical properties of biocomposite filaments made from lignin and polylactic acid for 3D printing. Composites B. Vol. 205. pg. 108483.

Ravishankar Mahadevan, Sushi Adhikari, Rajdeep Shakya and Oladiran Fasina. 2021. Influence of biomass inorganics on the functionality of H+ZSM-5 catalyst during in-situ catalytic fast pyrolysis. Catalysts, Vol. 11, pg. 124.

Hossein Jahromi, Sushil Adhikari, Poulami Roy, Ehsan Hassani, Conner Pope, Tae-Sik Oh and Yubaraj Karki. 2021. Production of green transportation fuels from Brassica carinata oil: A comparative study of noble and transition metal catalysts. Fuel Processing Technology, Vol. 215. Pg. 106737.

Pixiang Wang, Yuriy Sakhno, Sushil Adhikari, Haixin Peng, Deb Jaisi, Temitope Soneye*, Brendan Higgins, Qichen Wang. 2021. Effect of ammonia removal and biochar detoxification on anaerobic digestion of aqueous phase from municipal sludge hydrothermal liquefaction. Bioresource Technology. Vol. 326. Pg. 124730.

Tawsif Rahman, Hossein Jahromi, Poulami Roy, Sushil Adhikari, Ehsan Hassan, Tae-Sik Oh. 2021. Hydrothermal liquefaction of municipal sewage sludge: Effect of red mud catalyst in ethylene and inert ambiences. Energy Conversion and Management. Volume 245, pg. 114615.

Hossein Jahromi, Sushil Adhikari, Poulami Roy, Madison Shelley, Ehsan Hassani, Tae-Sik Oh. 2021. Synthesis of novel bio-lubricants from waste cooking oil and cyclic oxygenates through an integrated catalytic process. ACS Sustainable Chemistry & Engineering. Vol. 9 (21). pg. 13424-13437.

Journal Articles Published 2022
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. Chemsphere. https://doi.org/10.1016/j.chemosphere.2021.131934

Other Products
The group has added a bubbling fluidized bed pyrolysis unit to perform biomass pyrolysis experiments. Also, the group was awarded equipment grant to purchase a rotary kiln that will be used to produce biochar in large quantities.

Changes/Problems
The progress of our research group was hindered some due to the pandemic (COVID-19) and also the ability to recruit graduate students.

Bioenergy and bioproducts production through systematic metabolic engineering and bioprocess engineering of solventogenic clostridia

Project Director
Yi Wang
Organization
Auburn University
Accession Number
1014274

Bioenergy and bioproducts production through systematic metabolic engineering and bioprocess engineering of solventogenic clostridia

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

The finite nature of fossil fuels and their associated environmental impacts drive the nations of the world to seek alternative biobased
fuels and chemicals from renewable resources. Solventogenic clostridia possess unique features that are important for industrial bioprocesses.

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 this study, rational manipulation of biological pathways of solventogenic clostridia will be carried out to develop robust workhorses that can produce various high value biofuel and biochemicals including butanol, ester, fatty acids, and long-chain alcohols from low-value renewable lignocellulosic materials.

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

Target Audience
1) Stakeholders in academia interested in bioenergy and biochemical production through systematic genome engineering and bioprocess engineering;

2) People in agriculture and industry who want to make the production of biofuel and biochemical on the industrial scale;
3) Policymakers and funding agencies who highly value bioeconomy and environmental sustainability, and the general public who values renewable energy and environmental sustainability.

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

The primary goal of this project is to develop robust solventogenic clostridial workhorses and optimized bioprocesses for enhanced bioenergy and bioproducts production, which can benefit the southeastern and nationwide bioeconomy development. The specific objectives are as follows:
(1) Enhance the carbon source metabolism in solventogenic clostridia through metabolic engineering approaches, in order to improve the utilization of lignocellulosic carbon sources;
(2) Enhance the robustness of solventogenic clostridia through metabolic engineering, to improve the production of the desirable endproducts;
(3) Develop optimized bioprocesses based on the engineered solventogenic clostridia strains, to achieve efficient biochemical conversation for biofuel and bioproducts production.
(4) Evaluate lignocellulosic hydrolysates as the feedstock for biochemical production using engineered solventogenic clostridia.

What was accomplished under this goal?
In this project, our primary goal is to develop robust solventogenic clostridial strains and optimized bioprocesses for enhanced
bioenergy and bioproduct production, which will benefit the development of the southeastern and nationwide bioeconomy. The following have been accomplished under the specific objectives:
(1) Enhance the carbon source metabolism in solventogenic clostridia through metabolic engineering approaches, in order to improve the utilization of lignocellulosic carbon sources;
-- Engineer Clostridium tyrobutyricum for enhanced xylose metabolism.
During our fermentation, we noticed that the consumption of xylose is not as efficient as glucose in Clostridium tyrobutyricum.
In order to enhance the xylose metabolism in the strain, recently, we deleted the xylR gene (the repressor for xylose consumption when glucose is present) in Clostridium tyrobutyricum. The engineered strain (with xylR deletion) demonstrated enhanced xylose consumption rate and also improved butyrate production. This work was carried out based on the Clostridium tyrobutyricum mother strain for butyrate production. In the next step, we will implement this in Clostridium tyrobutyricum Δcat1::adhE2 strain to enhance its xylose metabolism for enhanced biobutanol production.

(2) Enhance the robustness of solventogenic clostridia through metabolic engineering, to improve the production of the desirable endproducts;
--Identification and investigation of autolysin genes in Clostridium saccharoperbutylacetonicum strain N1-4 for enhanced biobutanol production.
Biobutanol is a valuable biochemical and one of the most promising biofuels. Clostridium saccharoperbutylacetonicum N1-4 is
a hyper-butanol producing strain. However, its strong autolytic behavior leads to poor cell stability especially during continuous fermentation, thus limiting the applicability of the strain for long-term and industrial-scale processes. In this study,
we aimed to evaluate the role of autolysin genes within C. saccharoperbutylacetonicum genome related to cell autolysis and further develop more stable strains for enhanced butanol production. Firstly, putative autolysin encoding genes were identified
in the strain based on a comparison of amino acid sequence with homologous genes in other strains. Then, by overexpressing all these putative autolysin genes individually and characterizing the corresponding recombinant strains, four key genes were pinpointed to be responsible for significant cell autolysis activities. Further, these key genes were deleted using CRISPR-Cas 9. Fermentation characterization demonstrated enhanced performance of the resultant mutants. Results from this study reveal valuable insights concerning the role of autolysins for cell stability, solvent production, and provide an essential reference for developing robust strains for enhanced biofuel and biochemical production.

(3) Develop optimized bioprocesses based on the engineered solventogenic clostridia strains, to achieve efficient biochemical conversation for biofuel and bioproducts production.
a) Engineer Clostridium for renewable fatty acid ester production.
Production of renewable chemicals through biological routes is considered an urgent solution for the fossil energy crisis. However, endproduct toxicity inhibits microbial performance and is a key bottleneck for biochemical production. To address this challenge, here we report an example of biosynthesis of high-value and easy-recoverable derivatives to alleviate

endproduct toxicity and enhance bioproduction efficiency. By leveraging the natural pathways in solventogenic clostridia for co-producing acyl-CoAs, acids, and alcohols as precursors, through rational screening for host strains and enzymes, systematic metabolic engineering--including rational organization of ester-synthesizing enzymes inside of the cell, and elimination of putative prophages, we developed strains that can produce 20.3 g/L butyl acetate and 1.6 g/L butyl butyrate respectively, which were both the unprecedented levels in microbial hosts. Techno-economic analysis indicated a production cost of $986 per metric tonne for butyl acetate production from corn stover compared to the market price of $1,200-1,400 per metric tonne of butyl acetate, suggesting the economic competitiveness of our developed bioprocess. Our principles of selecting the most appropriate host for specific bioproduction and engineering microbial chassis to produce high-value and easy-separable endproducts are highly applicable to other bioprocesses, and could lead to breakthroughs in biofuel/biochemical production and the general bioeconomy.
b) Optimization of the fermentation conditions to achieve high butanol titer and yield. We have carried out additional optimization experiments to further enhance butanol production in our engineering Clostridium strains. Primarily, corresponding to the biphasic fermentation process of butanol production, we tried different fermentation conditions at two fermentation stages, particularly, with higher temperature and slightly higher pH for the first stage to ensure good cell growth, and then lower temperature and slightly lower pH for acid re-assimilation for enhanced solvent production. Based on such a strategy, we were able to obtain high butanol titer and yield, while keeping the acetate and ethanol production at low levels. It looks like the supplementation of methyl viologen also makes a big difference. Currently, we are conducting additional strain engineering and fermentation optimization to further enhance butanol production (titer, yield, and productivity).

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?
In this project, one PhD student, and one Post-doc have been trained. The PI trained the students for research techniques and experiment design as related to metabolic engineering, synthetic biology and bioprocess engineering.
In addition, results from this project have been used as teaching materials for the PD's lecture and integrated into the PD's teaching of the Metabolic Engineering for Bioprocess (BSEN 5270/6270) class as well as the guest lecture to Introduction to Applied Biotechnology (APBT 1000) class.

How have the results been disseminated to communities of interest?
The research results have been presented at the 2021 Institute of Biological Engineering (IBE) Annual Conference and also the International Symposium on Microbiology: One Health 2021 (virtual) conference. In addition, the results have also been disseminated through AU 'This is Research' Student Symposium, the College of Engineering graduate students poster showcase, the AU College of Agriculture Graduate Student Poster Showcase. Three peer-review journal articles have been published with high-impact journals. The results provided valuable references for the stakeholders and relevant communities of interest.

What do you plan to do during the next reporting period to accomplish the goals?
We will continue to work on the development of robust solventogenic Clostridium strains through genome engineering and optimization of bioprocesses for enhanced biofuel and biochemical production. Particularly, we will focus more on the development of strains for producing high-value bioproducts, and also the optimization of bioprocesses based on the developed strains to achieve efficient biofuel and bioproducts production.

Journal Articles Published 2021
J. Feng, J. Zhang, Y. Ma, Y. Feng, S. Wang, N. Guo, H. Wang, P. Wang, P. Jiménez-Bonilla, Y. Gu, J. Zhou, Z.T. Zhang, M. Cao, D. Jiang, S. Wang, X.W. Liu, Z. Shao, I. Borovok, H. Huang*, Y. Wang*. 2021. Renewable fatty acid ester production in Clostridium. Nature Communications. 12:4368.

P. Jiménez-Bonilla, J. Feng, S. Wang, J. Zhang, Y.F. Wang, D. Blersch, L.E. de-Bashan, P. Gaillard, L. Guo, Y. Wang*. 2021. Identification and investigation of autolysin genes in Clostridium saccharoperbutylacetonicum N1-4 for enhanced biobutanol production. Applied and Environmental Microbiology. 87:e02442-20.

J. Li, S. Shi, Y. Wang, Z. Jiang. 2021. Integrated production of optically pure L-lactic acid from paper mill sludge by simultaneous saccharification and co-fermentation (SSCF). Waste management. 129:35-46.

S. Lu, H. Jin, Y. Wang, Y. Tao. Genome-wide transcriptomic analysis of n-caproic acid production in Ruminococcaceae

bacterium CPB6 with lactate supplementation. Journal of Microbiology and Biotechnology 2021, 31.
NIFA Support Acknowledged
NO

Journal Articles Published 2020
J. Lian, Y. Wang*, Y. Luo, C. Li. 2020. Development and application of novel genome engineering tools in microbial biotechnology. Frontiers in Bioengineering and Biotechnology. 8:1415.

Patent(s) and Plant Variety Protection(s)
US 11,142,751 09/08/2021 CRISPR-Cas system for Clostridium genome engineering and recombinant strains produced thereof

PCT/US20/66452 12/21/2020 Microbial ester production

Development of new wood composites for packaging applications

Project Director
Brian Via
Organization
Auburn University
Accession Number
1012339

Development of new wood composites for packaging applications Accession No. Reporting Period

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

Wood composites for packaging will be pursued for either crates or pallets. Typically, composites like Oriented Strand Board (OSB) is designed for higher loads, so this project will work towards a lighter weight and less strong composite which is more sustainable and less costly.

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.

New sustainable adhesives will be used to adhere the wood flakes together. Ways to lower the material density and to lower the press time will be pursued to use less petroleum based energy during transport or during pressing respectively. Hydrophobic wood composites will be pursued to improve the quality of the packaging.

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

The target audience was oriented strand board manufacturers. We presented the results at two Forest Products Society events which had over 100 people from mostly companies in this target area. The target audience is interested in making lower-density composites because it is lighter weight, reduces costs, and/or is more environmentally friendly.

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

Obj. 1. Identify potential packaging markets for wood composite materials. Determine the specifications and needs important for that market.
During this project period, we met with 2 wood composite manufacturers and 2 adhesive suppliers to discuss market needs. Because of nondisclosure agreements, we cannot provide their names. We continued to reach out to other wood composite manufacturers. We also determined the needs and specifications for each company and then tried to provide or collect data to see if we could meet their needs. Each company has a different target market and often has different preferences beyond the minimum engineering standards/codes.
Obj. 4 Develop patents for new technology and/or leverage findings for external funding
A second patent was awarded on January 26, 2021, utilizing soy for wood composites and a patent number was given by the U.S. Patent and Trademark Office Patent No.: US 10,899,039 B2. The present invention provides adequate bonding at reduced costs due to lower soy flour prices than petroleum-based adhesives. Methods were provided to formulate binders for

wood composites comprising neat soy flour mixed with petroleum-based adhesives. These soy formulations were prepared by
mixing with the adhesive and then sequentially adding to the composite.

We were also able to leverage external funding to assist with the soy adhesive component of this project. The following sources of external funding were secured during 2021:

Soy Flour Based Resins For Hot And Cold-Pressed Wood Products
Via
United Soybean Board
1 year
$146,000

Use of Soy Flour in Engineered Wood Products in Alabama
Via
State Alabama Farmers Federation Soybean Producers
1 year
$13,900

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?
Two postdocs were trained by the company PerkinElmer to use chemometrics software to analyze data and perform multivariate modeling for packaging applications.

How have the results been disseminated to communities of interest?
We demonstrated results at a Forest Products Society Conference and webinar event. We reached an audience of more than 100 people from at least 10 manufacturers in the target market group. We also published these manuscripts in peer-reviewed journals.

What do you plan to do during the next reporting period to accomplish the goals?
We plan to continue to apply for funding to a) addition of soy flour to wood composite adhesives and b) develop sensors to

Journal Articles Published 2021
Peng, Y., Xia, C., & Via, B. (2021). Characterization of Cellulose Nanocrystal Suspension Rheological Properties Using a Rotational Viscometer. Forest Products Journal, 71(3), 290-297.

Peng, Y., & Via, B. (2021). The Effect of Cellulose Nanocrystal Suspension Treatment on Suspension Viscosity and Casted Film Property. Polymers, 13(13), 2168.

Hornus, M., Via, B. K., Gallagher, T., & Peresin, M. S. (2021). Partial substitution of pMDI with lignin containing cellulose nanofibrils: Low density oriented strand board. Wood Material Science & Engineering, 16(6), 391-396.

Other Published 2021
Via, B.K., & Banerjee, S. (2021). "Soy-modified resins for bonding wood." U.S. Patent No. 10,899,039. Washington, DC:

U.S. Patent and Trademark Office.
Provisional App. No. 09/29/2022 Paper-based Formaldehyde sensor (PFS)detect formaldehyde in food-based packaging.

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

Integration of anaerobic digestion with algae cultivation for conversion of agricultural wastes to bioenergy, clean water, and animal feed

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

As one of the largest poultry producers in the United States, Alabama is estimated to produce roughly 1 million tons of poultry litter and manure waste per year. Currently, this litter is typically stored in piles on site until it can be transported to agriculture
fields where it is used as a fertilizer substitute. This practice often leads to overloading fields with phosphorus, limiting the time
and locations where litter can be applied. Uncontrolled breakdown of organic material during litter storage also can lead to methane emissions, a potent greenhouse gas.

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

In the proposed research, we will investigate an alternative approach to poultry litter management that will lead to reduced environmental impacts and greater income for farmers. Specifically, we will study a process that combines anaerobic digestion with algae cultivation on the digester effluent. The digester will convert organic material into energy-rich biogas while the algae will sequester nutrients (e.g. phosphorus). The growing algae also produce oil and protein which will be used for biofuel and fish feed production. Successful deployment of this technology will reduce greenhouse gas emissions and nutrient pollution while raising the value of poultry litter, resulting in greater farmer income. However, there are several key technical challenges that need to be overcome before this technology can be commercialized: 1) recalcitrance of poultry litter to digestion, 2) integration of digester and algae technology, and 3) use of algal biomass for fuel and feed. This project aims to make advances in all three of these challenge areas by using advanced research methods including anaerobic and aerobic bioreactor operation, analytical chemistry, and molecular biology tools.

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

Target Audience
1. Academic community of Biosystems Engineers
2. Poultry Growers
3. Dairy farmers
4. Poultry processors
5. Wastewater Utilities

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

The proposed research investigates conversion of agricultural waste material into value-added energy resources and animal feed through combined anaerobic digestion and algal treatment. Poultry litter waste will serve as a testbed for developing this
technology with plans for future expansion into other agricultural waste streams. This project holds the potential to extract greater value from poultry litter while reducing environmental impacts compared to existing practice. The research objectives for this project align with critical technology bottlenecks:
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:
In fiscal year 2021, we wrote and published a peer-reviewed article pertaining to biological phosphorus solubilization in poultry

litter. This study investigated both the effects of moisture content and aerobic vs. anaerobic conditions in a full factorial design. We found that the high-moisture anaerobic conditions led to the highest amount of water and bicarbonate-extractable
(i.e. labile) phosphate. Low moisture had the opposite effect with regard to phosphorus but led to slightly greater (but statistically significant) nitrification. Aeration of the litter had no effect on phosphorus solubility but stripped ammonia and is therefore unlikely to be a useful strategy for litter nutrient management. The implication of the study is that high moisture litter storage conditions can lead to biological activity that improves the extractability of phosphorus from litter. In contrast, if the litter is to be directly applied to fields, low moisture storage can better stabilize the phosphorus, potentially reducing leachability during rainfall events. This paper was published in the Journal of Environmental Management (IF 6.789).

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 2021 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 adapting and testing the use of a native algae consortium that we obtained from the Auburn University EW Shell Fisheries Station. In one study, we adapted this consortium first to pretreated dairy anaerobic digestate and then to pretreated municipal anaerobic digestate. We also studied how the bacterial and algal community evolved during the adaptation and found dramatic restructuring away from Euglenoids and toward members of Scenedesmaceae and Chlorellaceae. Once adapted to the extreme digestate environments, we compared the effectiveness of this consortium (growth and nutrient removal ability) versus our "gold standard" algae monoculture (Chlorella sorokiniana). Although the consortium did not grow or remove nutrients as quickly as the monocultures we tested, we still found that the pretreatment process was very helpful in facilitating growth and nutrient removal (increases of over 100%). Although the consortium was less effective than C. sorokiniana, the use of native algae will very likely be a requirement in real-world use of this technology. This work was published in Bioresource Technology (IF 9.642).

We also completed a full year of outdoor study of our algal treatment system for anaerobic digestion. This study used the native algae consortium. The study was carried out in three 2 L photobioreactors and began in October of 2020 and ended in October of 2021. These reactors saw a wide range of weather conditions from hurricanes to below freezing to excruciating summer humidity. We had run-ins with native wildlife who took interest in the outdoor setup but overall, the system performed remarkably well; we could achieve growth (albeit slow) in the winter and saw rapid growth throughout spring and fall. The only point in which the system completely crashed was when we purposely stopped pretreating the aerobic digestate feed to see what would happen. All algae died within a few days and it took several weeks for the process to recover once we began pretreating again. The result underscores the importance of anaerobic digestate pretreatment, given that no dilution of digestate was performed.

In fiscal year 2021, 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. Expanding on our 2020 work, we tested the ability of algae to promote nitrification in poultry processing wastewater in the presence and absence of antimicrobial chemicals. These chemicals not only kill pathogens but also harm the nitrifying bacteria needed for wastewater treatment. We have now shown that adding algae to the nitrification process can overcome the negative impacts of antimicrobial agents. In 2021, we conducted a batch study investigating the ways in which two different green algae species can promote nitrification in poultry processing wastewater. We found that both of these algae could promote nitrification in the absence and presence of both peracetic acid (most common processing aid) and cetylpyridinium chloride (another common processing aid). We also conducted a long-term (200 day) study in which we compared a bacteria-only treatment reactor to a reactor using both bacteria and algae. At low solids content, we found that algae grew rapidly and outcompeted nitrifiers for ammonium (sequestering it in biomass). Under high solids content, algae promoted nitrification. The results show that altering the solids content in the reactor governs the relationship between algae and nitrifying bacteria. Finally, we have nearly completed construction on a pilot-scale system for poultry wastewater nitrification in conjunction with hydroponic lettuce production.

Goal 3:

In partnership with faculty in the School of Fisheries and Aquatic Sciences, we published work on feeding wastewater-grown algae to the zooplankton Daphnia pulicaria. Daphnia and related zooplankton are an existing source of fish feed. Fish farmers often fertilize ponds to stimulate growth of phytoplankton and zooplankton that serve as fish food. We published our work on feeding digestate-grown Chlorella to Daphnia in the Journal of Cleaner Production (IF 9.297). We conducted further studies on somatic and population growth of Daphnia fed with our native algal polyculture (from Goal 2 activities). We found that this native consortium supports even better Daphnia growth than the previously-studied Chlorella cultures. This is encouraging because native polycultures are the only way this system will be able to operate cost-effectively in an agricultural setting.

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

This project has resulted in the training of two PhD students, five master's students, and two undergraduate student researchers over the 2021 fiscal year. Three of the master's students graduated with degrees in Biosystems Engineering in 2021. Many of these students have had opportunities to present their work at conferences and symposia despite the pandemic. Four of my students were the first authors on papers published in 2021.

How have the results been disseminated 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 and a dairy farmer who have kindly provided us with materials. We have also communicated results with wastewater utilities who have also contributed material support for this project.

What do you plan to do during the next reporting period to accomplish the goals?
Goal 1: There are no plans to continue research toward this goal given the conclusive nature of findings. We have published three peer reviewed papers in this area and Higgins has co-authored two additional papers with others.

Goal 2: We have ongoing studies to improve understanding of the types of inhibitory compounds present in anaerobic digestates. We are also pursuing a further investigation into the conditions and means by which algae promote nitrification, particularly in the presence of antimicrobial compounds. We will engage in extended reactor run times using our new pilot scale nitrification reactor system. This system will be used in experimental studies in which we (in collaboration with horticulture researchers) irrigate hydroponic crops with treated poultry processing wastewater.

Goal 3: We will continue experiments aimed at understanding algal biomass composition changes in response to different digestate growth conditions. We will conduct experiments in which we explore zooplankton sensitivity to the high ammonium levels found in algal biomass that was grown in anaerobic digestate. We will also expand beyond Daphnia and investigate feeding crawfish and/or freshwater shrimp using our algal biomass.

Journal Articles Accepted 2021
Melby, E., B.T. Higgins. Neutral Lipid Accumulation in Algae by Oxidative Stress Due to Poultry Wastewater Antimicrobials. Auburn University Journal of Undergraduate Scholarship: 2021 issue.

Higgins, B.T., K. Chaump, Q. Wang, R. Prasad, P. Dey. 2021. Moisture content and aeration control mineral nutrient solubility in poultry litter. Journal of Environmental Management. 300. 113787.

Wang, Q., J. Cherones, B.T. Higgins. 2021. Acclimation of an algal consortium to sequester nutrients from anaerobic digestate. Bioresource technology. 342. 125921.

M. Hyman, Q. Wang, A.E. Wilson, S. Adhikari, and B.T. Higgins. 2021. Production of Daphnia zooplankton on wastewatergrown algae for sustainable conversion of waste nutrients to fish feed. Journal of Cleaner Production. 310. 127501.

A. Fallahi, F. Rezvani, H. Asgharnejad, E. Khorshidi, N. Hajinajaf, B.T. Higgins. 2021. Interactions of Microalgae-Bacteria Consortia for Nutrient Removal from Wastewater: a Review. Chemosphere. 129878.

Wang, P., Y. Sakhno, S. Adhikari, H. Peng, D. Jaisi, T. Soneye, B.T. Higgins, Q. Wang. 2021. Effect of ammonia removal and biochar detoxification on anaerobic digestion of aqueous phase from municipal sludge hydrothermal liquefaction. Bioresource Technology. 326. 124730.

Changes/Problems
There are no major changes to the project goals, notwithstanding our previously-described shift in the focus for goal 1. Minor evolution in the foci of Goals 2 and 3 continue to occur as a result of discoveries made to date. However, the overarching theme of these goals remains the same: using algal bacterial processes to recover nutrients from agricultural waste streams and efficiently recycle them back into food and feed.

Nanocellulose-based materials for novel applications

Project Director
Maria Peresin
Organization
Auburn University
Accession Number
1012338

Nanocellulose-based materials for novel applications

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

Nanocellulose particles (nanocrystalline and nanofibrillated cellulose) from different lignocellulosic local sources with different
chemical compositions (i.e. abandoned wood sources such as bark, sawdust; non-wood and agri-food waste streams sources such as hemp, wheat straw, cotton, soy hulls, pecan hulls, invasive species, etc.) using complementing processing 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.

After proper characterization, they will be utilized to prepare adhesives formulations for wood composites (oriented strand boards); films nanocomposites for packaging and filters for water remediation. The performance of this materials will be studied in terms of their final applications as a correlation on the chemical composition of the starting sources.

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

During this reporting period, in addition to the dissemination of results to federal agencies, NGOs, and the private sector, increased efforts were made to engage a diverse audience from other academic institutions of the region, country, and abroad. More specifically, Latin-American research institutions were targeted in order to increase the recruitment of graduate students.

Active engagement and strengthening of the academic collaboration with Tuskegee University has resulted in the hire of the first African American undergraduate student researcher co-advised between myself and the TU partner, Dr. Michael Curry. Several news articles portraying this research have been posted on the University website and picked up by several news outlets, including local newspapers. Research was portrayed in Birmingham Business Journal, reaching a more diverse audience.

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

A major goal of this project is to isolate nanocellulose from different sources with varying chemical compositions to prepare OSB boards, film composites, membranes and filters for water purification.
Specific objectives of the project include:

1. Understanding the role of residual lignin and hemicelluloses in nanocellulose from different sources.
2. To elucidate the distribution and location and the effect of remaining lignin between cellulose nanofibrils after mechanical disintegration of unbleached pulps.
3. To evaluate the effect of the presence of lignin on surface energy, adhesion parameters and interphase interactions of CNF and its nanocomposites i n terms o f performance o f the final product.
4. To study and develop efficient strategies to improve interfacial adhesion between the nanofibrils and polymeric matrix to maximize the strength of final products (e.g. nanocomposites).
Obj. 1-3. To accomplish these goals, in this reporting period, cellulose from soybean hulls, oats, and from wood was studied, focusing on their surface charge and zeta potential, as well as in its rheological behavior.
Obj. 3-4. Bleached cellulose nanofibrils were then used to generate hydrogels by solubilizing them in urea-sodium hydroxide and regenerated in nitric acid solutions. Bead-shaped structures were obtained and utilized as scaffolds to generate silver nanoparticles aiming to use them as water filtration systems. Tests with known concentrations of E. coli are being performed.

Likewise, the soybean-derived nanoparticles had been oxidized with a TEMPO mediated reaction to increase carboxyl content. These nanoparticles were then passively assembled into hydrogels when coordinated by calcium and zinc ions. The hydrogels were coated with polyelectrolytes and studied for the removal of dyes and other water contaminants. Adsorption and assembly tests were also done with quartz crystal microbalance with dissipation monitoring to better understand the interfacial phenomena.
Wood nanoparticles were used as a replacement for urea formaldehyde resins in the generation of particle boards. Thickness swelling, water absorption, modulus of elasticity and rupture were studied, finding better interactions when lignin-containing nanoparticles were utilized.

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?
One high school graduate, six undergraduate students, five graduate students and two visiting scholars were trained resulting in 8 peer-reviewed articles plus data for 12 more publications has been gathered. Two undergraduate researchers under my supervision graduated and went to pursue graduate degrees at the University of British Columbia and North Caroline State University. One PhD advisee obtained his doctoral degree under my supervision. Two graduate students were awarded outstanding graduate students fellowships at School and University levels.

I am a member of the Advisory Board for the Young Professionals in Training (YPIT) program. YPIT is a mentoring and tutoring program for students in 5th-12th grade. The program will expose students from underrepresented populations to majors and careers on Auburn University's campus. YPIT is a collaboration between Auburn University Outreach, Truman Pierce Institute (TPI), and the Curtis House, a local non-profit. YPIT seeks to understand participants' challenges and needs by allowing them to be the drivers of the program. The ultimate goal of the program is to empower the participants and offer a
pathway to Auburn University while increasing the diverse background of the AU students. In addition to this, in this reporting period, I began to work very closely with the advisor of Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) AU Chapter, which is housed at the School of Forestry and Wildlife Sciences. MANRRS mission is to promote academic and professional advancement by empowering minorities in agriculture, natural resources, and related sciences.

How have the results been disseminated to communities of interest?
The following presentations and invited talks were delivered:
V International Congress in Biotechnology and Biodiversity, organized by the Biotechnology Center (CIBE) from the ESPOL Polytechnic in Ecuador (2020) Invited talk: Nanocellulose and its applications.

2021 Science Week. Applied nanotechnology in water contaminants removal. Organized by the Engineering and Technologies Innovation Division from the CUT Universidad de Guadalajara in Mexico (2021). Hernandez, J. A. Invited talk and round table discussion: Nanocellulose membranes obtained from bagasse of agave tequilana var. weber for removal of emerging contaminants in water.

*Hernandez, J. A. & Peresin, M. S. (2021). Lignin nanoparticles for protective coatings of mass timber products. Auburn Research 2021 Student Symposium. Top Graduate Oral presentation award for the School of Forestry and Wildlife Sciences.

*Hernandez, J. A., Musah, M., Via, B., & Peresin, M. S. (2021). Downed timber degradation of loblolly pine in south Alabama and potential recovery of natural polymers for value-added applications. Southeast Regional Meeting of the American Chemical Society (SERMACS) Fall Symposium 2021. First place oral presentation award for the Engineering Solutions for Social Challenges: Renewable Materials and Resources symposium.

*Iglesias, M. C., Hamade, F., Davis, V. A., and Peresin, M. S. (2021). Effect of chemical composition on the rheological behavior of lignin-containing cellulose nanofibrils (LCNFs) suspensions obtained from Kraft softwood pulp. 258th American Chemical Society (ACS), National Meeting and Exposition, Virtual conference.

Gomez-Maldonado, D., Reynolds, A.M., Babu, J.R., Waters, M.N., & Peresin, M.S. (2021). Using cyclodextrin grafted chitosan as coating of delignified wood aerogels for the removal of microcystin-LR. In Engineering Solutions for Social Challenges: Renewable Materials and Resources at Southeastern Regional Meeting 2021 American Chemical Society. November 13, 2021. Invited speaker

Nan, Y., Gomez-Maldonado, D., Whitehead, D., & Peresin, M.S. (2021). Cellulose nanofiber-based hydrogel for removal methyl blue dyes in water resources. In Engineering Solutions for Social Challenges: Renewable Materials and Resources at Southeastern Regional Meeting 2021 American Chemical Society. November 13, 2021.

Brake, S., Gomez-Maldonado, D., Zohdy, S., & Peresin, M.S. (2021). On the Road to Developing Sustainable Alternative Materials for Long-lasting Insecticide Nets: Cellulose-based Insecticidal Fiber Yarn for Malaria Control. In Engineering Solutions for Social Challenges: Renewable Materials and Resources at Southeastern Regional Meeting 2021 American Chemical Society. November 13, 2021.

Reynolds, A.M., Gomez-Maldonado, D., Ramapuram, J.B., Waters, M.N., Peresin, M.S. (2021). Delignified wood aerogel as scaffolds coated with chitosan-cyclodextrin co-polymer for removal of microcystin-LR, ACS Spring 2021 Macromolecular chemistry: the second century, April 5-16, virtual at https://acs.digitellinc.com/acs/live/8/page/18.com.

Gomez-Maldonado, D., Vega Erramuspe, I.B., Filpponen, I., Johansson, L.-S., Ramapuram, J.B., Waters, M.N., Peresin, M.S. (2021). Oriented β-cyclodextrin/chitosan polymer as an active coating on 2D and 3D nanocellulose surfaces and its efficiency in microcystin-LR capture, ACS Spring 2021 Macromolecular chemistry: the second century, April 5-16, virtual at https://acs.digitellinc.com/acs/live/8/page/18.com.

Reynolds, A.M., Gomez-Maldonado, D., Ramapuram, J.B., Waters, M.N., Peresin, M.S. (2021). Cost efficient functionalized bio-based aerogels for microcystin L-R removal from surface water, 2021 AU Student Research Symposium, March 29-April 2, virtual at https://auburn.app.box.com/s/0cmadgkk3wmqc61btxuj11tly2dek8me. School Undergraduate presentation award

Gomez-Maldonado, D., Vega Erramuspe, I.B., Filpponen, I., Johansson, L.-S., Ramapuram, J.B., Waters, M.N., Peresin, M.S. (2021). Bio-based active coatings for2D and 3D nanocellulose surfaces and its efficiency in microcystin-LR capture, 2021 AU Student Research Symposium, March 29-April 2, virtual at https://auburn.app.box.com/s/0cmadgkk3wmqc61btxuj11tly2dek8me.

*Nan, Y., Gomez-Maldonado, D., Peresin, M.S. (2021). Natural polymer-based nanocomposites for water remediation. Poster session 2021, School of Forestry and Wildlife Science, Auburn University, AL. July 13

*Brake, S., Gomez-Maldonado, D., Zohdy, S., Peresin, M.S. (2021). Cellulose-based Insecticidal Fiber Yarn for Malaria Control: A Sustainable Alternative to Long-lasting Insecticide Nets. Poster session 2021, School of Forestry and Wildlife Science, Auburn University, AL. July 13

*Au, G., Gomez-Maldonado, D., Peresin, M.S. (2021). Biosensing and Antimicrobial Applications of Biomaterials. Poster session 2021, School of Forestry and Wildlife Science, Auburn University, AL. July 13

*Gomez-Maldonado, D., Peresin, M.S. (2021). Understanding the surface phenomena for advanced materials. Poster session 2021, School of Forestry and Wildlife Science, Auburn University, AL. July 13

*Nan Y., Gomez-Maldonado, D., Peresin, M.S. (2021). Polyethyleneimine functionalized cellulose nanofiber hydrogel as an efficient adsorbent for toxic dyes removal from wastewater. 2021 AU Student Research Symposium, March 29-April 2, virtual at https://auburn.app.box.com/s/0cmadgkk3wmqc61btxuj11tly2dek8me. School Graduate poster presentation award

What do you plan to do during the next reporting period to accomplish the goals?
During the next funding period, efforts will be focused on leveraging the fundamental knowledge gathered thus far into the development of products closer to the market.

Type

Projects / Programs without a Critical Issue

Not Provided

Projects / Programs

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