Alabama Research and Development Enhancement Fund
Quarterly Report
Presented July 2021

mary.blackmon@adeca.alabama.gov

Street Address: 401 Adams Avenue, Suite 560
Montgomery, Alabama 36104-4325

Mailing Address: Post Office Box 5690
Montgomery, Alabama 36103-5690

Background

The Alabama Innovation Act (AIA) was established by Legislative Act #2019-404 and became effective June 6, 2019. The Act designated the Alabama Department of Economic and Community Affairs (ADECA) as the state agency to establish and administer the Alabama Research and Development Enhancement Fund (ARDEF) Program.

The purpose of the ARDEF Program is to encourage new and continuing efforts to conduct research and development activities within the state. The Fund is designated to receive appropriations from the legislature, or from the receipt of gifts, grants, or federal funds to be expended for the purpose of increasing employment opportunities and products and services available to the citizens of Alabama.

Overview of 2020 Program Year

Projects Funded Under 2020 Round One Grant Period

Applicant	Amount
Auburn University - Removal of Per – and Polyfluoroalkyl Substances (PFAS) in Water and Landfill Leachate in Alabama	$193,960.00
Auburn University - Knitting Micro-Resolution Mosquito Bite Blocking Textiles	$868,145.00
Auburn University - Advanced Biosensors from Forestry Products and Agricultural Resources	$245,864.77
HudsonAlpha Institute for Biotechnology - Advancing Genomic Health in Community Clinics and Employee Wellness Settings	$969,409.00

Auburn University – Removal of Per – and Polyfluoroalkyl Substances (PFAS) in Water and Landfill Leachate in Alabama

This project aimed to remove and destroy the so-called forever chemicals, per- and polyfluoroalkyl substances (PFAS), from Alabama water and landfill leachate. PFAS have been detected in chemical manufacturing wastes and landfill leachate in Alabama and have caused some serious cases of drinking water contamination in the state. Ongoing health concerns and regulatory development associated with PFAS are threatening the sustainable development of the Alabama economy and business. The goal of this research was to develop an innovative "Concentrate-&-Destroy" technology to cost-effectively remove and degrade PFAS in water and landfill leachate. The new remediation technology will provide the affected industries and water utilities with a powerful remediation means to mitigate the PFAS-related issues, thereby assuring sustainable development of the economy and the wellbeing of Alabama citizens.

Within this quarter, the project has made progress on two major tasks. These tasks revolved around the development and testing of a new material designed for treating short-chain PFAS (GenX as a model PFAS), and the characterization of the leachate and stream water collected from two Alabama sites. The team has developed and tested a new photocatalyst (Bi/TNTs@AC) for adsorption and photocatalytic degradation of GenX, which is a substitute chemical for PFOA, yet, is feared to show similar or higher toxicity than PFOA. The results showed that Bi/TNTs@AC was able to rapidly and nearly completely adsorb GenX within 60 min from synthetic water, and then 43% of the pre-sorbed GenX can be mineralized under UV

light for 4 hours. In addition, our preliminary analytical results showed that 18 PFAS were detected in the landfill leachate and 7 PFAS in the stream water, and several of the PFAS showed concentrations orders of magnitude higher than the EPA advisory levels. These data will be double-checked in the next quarter.

Auburn University – Knitting Micro-Resolution Mosquito Bite Blocking Textiles

Insects transmit crippling diseases to humans. Nearly a half million people die of malaria each year. In Alabama, citizens encounter Dengue and Zika virus invasions as well as a multitude of encephalitis variants. The worse vector borne diseases are transmitted in the hottest climates like Alabama, and it is uncomfortable to wear the thickest clothing. This project will research different textile and weave patterns to create clothing that is cool in heat and capable of blocking mosquito bites and develop prototypes based on this research. Beyond the prototype phase, research will be done to measure the effectiveness this product will have on the Alabama economy.

A knitting manufacturing lab was set up in Auburn, Alabama. Three machines were imported and installed including a Stoll ADF flatbed knitting machine from Germany, a Lonati circular knitting machine from Italy, and an Agtek threadtwister from Turkey. Training on the machines was completed. The Auburn knitting lab is now fully functional, and we are now designing and knitting sleeve prototypes in-house. During this quarter we trained with the Agtek fiber winder which is capable of twisting novel yarn geometries. As of this quarter we have completed the main objectives of Aim 1 and are now managing our own active knitting lab in Auburn, Alabama. During this quarter we designed, knitted, and tested a total of 35 novel knit prototypes. Importantly, we were able to identify and refine our key hypotheses about knit variables that lead to mosquito bite blocking.

Auburn University – Advanced Biosensors from Forestry Products and Agricultural Resources

The main goal of this project is to utilize Alabama's forestry products and agricultural resources for extracting cellulosic nanomaterials (CNM) by using these nanomaterials in advanced biosensing. As timber production and other agricultural products are essential for the economy in Alabama, these materials are a great resource for obtaining cellulosic nanomaterials. In this work, the Auburn University research team has explored CNMs from three different sources: cotton, soybean hulls, and wood. Irrespective of sources, these nanomaterials demonstrated great potential of being employed in advanced biosensing. Initially, the team has explored antibody-based detection of two emergent water contaminants with surface modified CNC. Successful detection of analytes was achieved. However, antibody-based schemes can be limited by a lack of specificity and antibody expense could overshadow accessibility to this technology. Therefore, while the initial results were a successful initial demonstration of the potential of CNMs in biosensing, the AU research team is planning on a new detection route which will overcome the limitations of antibody-based biosensors. The AU team will also employ Surface Plasmon Resonance (SPR) in addition to Quartz Crystal Microbalance with Dissipation (QCM-D) to investigate the sensing at a molecular level. Outstanding lab facilities along with the support from ADECA are enabling scientific knowledge contributions and revalorization of agricultural and forestry waste products as biosensors.

HudsonAlpha Institute for Biotechnology – Advancing Genomic Health in Community Clinics and Employee Wellness Settings

Genomic medicine is a form of precision medicine that uses approaches customized to each patient to treat disease and optimize prescription medicine based on a genetic profile. This project will test and develop a genomic health complete delivery system for Alabama patients and physicians at healthcare systems and community hospitals with limited expertise in genomics. This system includes 1) Partnering with Auburn University to develop community-based models for health programs, 2) Refining and optimizing the process including insuring access by rural areas that are underserved, and 3) Developing the health IT infrastructure needed to fully integrate genetic test reporting and education into an electronic health records system. The proposed development of new products and services will result in improved health outcomes for Alabamians, opportunities for employers to increase competitiveness and reduce costs, and modernization of health care in an equitable way for Alabama communities, large and small, regardless of socioeconomic status.

The HudsonAlpha ADECA/ARDEF project will develop and optimize genetic health screening programs with multiple partners around the state of Alabama, including large employers offering genetic testing to their employees. Phase 1 of this project will involve Auburn University and provide 1000 Auburn employees with pharmacogenetic testing to identify medications that may or may not be optimal for some individuals with genetic factors that influence the metabolism of these medications. Phase 2 will take lessons learned from the Auburn project and deliver similar programs to other entities around the state, in diverse clinical settings. We have made progress in the most recent quarter by continuing to expand pharmacogenetic testing at existing partner sites (Auburn University, Miles College), and establishing new ADECA/ARDEF-funded programs (East Alabama Health). We are currently finalizing agreements with two additional universities, one corporation, and one municipal government. We also received IRB approval for a research protocol that will enable survey-based data collection from participants to enable research around the perceptions and health benefits of these programs.

Projects Funded Under 2020 Round Two Grant Period

Applicant	**Amount**
University of Alabama in Huntsville- Alabama Business Resiliency and Sustainability Index and Roadmap	$ 746,104.00
University of Alabama in Huntsville – Rural Employment and the need for an Alabama Irrigated Acreage Survey, Demand Estimate and Forecast	$ 172,073.00
University of Alabama at Birmingham-A Comprehensive Data Science Software Toolkit to Improve Alabama's Mobility Planning for Serving Businesses and Vulnerable Populations	$ 394,926.00
Auburn University-Design, Fabrication and Testing of Novel Medical Facemasks to Prevent COVID-19	$ 75,374.00
Auburn University-Formaldehyde paper-based device (PAD) for a cost-efficient detection of formaldehyde emissions from wood panels	$ 247,142.00
University of Alabama at Birmingham-Commercialization of small diameter artificial vascular graft for an animal trial	$ 906,458.00
Bashan Institute of Science-Exploring the use of cellulose fibers as microcapsules for plant growth-promoting bacteria (PGPB) inoculants	$ 7,500.00

University of Alabama in Huntsville – Alabama Business Resiliency and Sustainability Index and Roadmap

Recent events, such as the global COVID-19 pandemic, are having detrimental impacts on companies throughout Alabama, including the products and services they provide and the citizens they employ. Other impactful events that can occur may include the sudden loss of a major customer or supplier, a natural disaster, or even a diminishing source of skilled labor. The objective of this project is to research potential impacts on businesses and organizations across several business sectors to develop and deploy a comprehensive Resiliency and Sustainability Index and Roadmap (RSIR) model. The RSIR can be further tailored to fit each business sector and individual organization. Additionally, the UAH team will directly support businesses in the customization and implementation of their RSIR along with assistance in developing the ability to execute the roadmap and plan should the need arise.

During this reporting period, progress has been made in three phases of the Reliability and Sustainability Index and Roadmap (RSIR) project:

- Continuation of Research Potential Impacts by Sector
- Beginning Research and Development of the RSIR
- Defining the Engagement Process

Research is near complete for the Potential Impacts by Sector. Numerous resources have been reviewed, including journal articles, books, industry publications, research studies and news articles. Information was then compiled to capture categorizations of disruptive events as well as categorizations of the effects the events have on various types of businesses. There are currently six high-level categories of effects that can be mapped to each of the categories of disruptive events. Research and Development of the RSIR model has also progressed significantly during this reporting period. The model is constructed around the business systems of an organization and their functions. Each of the categories of effects are not only mapped to the disruptive event types, but also to the business systems and functions they impact. The model will evaluate capabilities a business has in place in three areas of resilience: Readiness, Response, and Recovery. An assessment will be conducted to evaluate the capabilities of the practices in place in each of these areas and generate a score. The model is being constructed to allow a drill-down investigation into the score to identify opportunities for improvement and allow for cross-cutting the results to look at components of the score by business system, disruptive event type, or even capabilities related to typical key performance indicators, such as quality, cost and delivery.
As the model is being constructed, the Engagement Process is also being constructed. The Engagement Process defines how the companies will be engaged in the assessment process and what will be accomplished in each of the three phases of the engagement. The first phase will capture general information about the company that can be used to tailor the RSIR model to only those components relative to the company and the sector in which they reside. The second phase consists of the detailed assessment and results in the RSIR score and roadmap to improvement. The third phase engages the business in one-on-one support to implement improved practices that will increase their resilience.

University of Alabama in Huntsville – Rural Employment and the Need for an Alabama Irrigated Acreage Survey, Demand Estimate and Forecast

As irrigated agriculture develops in our rural communities, it is imperative Alabama has the tools and data needed to ensure water resources are available for sustainable economic development. The goals of this project are to update the existing manual center pivot irrigation survey

completed by UAH for the years to include 2017 and 2019 and develop a state-specific machine-learning framework from multiple sources of remote sensing products to efficiently and semi-autonomously identify the irrigated areas in Alabama to include all irrigated land such as golf courses and other irrigation system types beyond just center pivots. This information will be used to update the report "Estimates of Future Agricultural Water Withdrawal in Alabama", produced by the Water Resources Center, Auburn University for OWR in 2017. The result will include updated estimates as well as methodologies utilizing more recent urban growth and land use change data. The results and outcomes of this project will support the Alabama Department of Economic and Community Affairs (ADECA) Office of Water Resources (OWR) to accurately analyze and forecast water use across the State.

Activities of the second quarter focused primarily on updating the manual center pivot irrigation mapping survey and the development of a preliminary machine learning model for mapping irrigated lands. The UAH and Auburn teams conducted a kick-off meeting to get the students started with the manual survey efforts. A first round of surveys was evaluated initially to ensure quality control. Mapping of 2017 center pivots are now underway and are expecting to finish 2017 this quarter and start on the 2019. Three students are conducting the mapping exercise under the advisement of UAH and Auburn. Currently, over half of the State has been surveyed for 2017. A masters student in computer science has been recruited to conduct the machine learning task of the project. A literature review was performed and methods such as IrrMapper, LANID RF and IrrMapper UNET were compared and evaluated against each other. Currently datasets (including precipitation, NDVI, NDWI etc.) are being compiled in the Google Earth Engine framework to reimplement the IrrMapper UNET over North Alabama as a pilot set up. Lastly, an overall team project meeting was held in June that brought all aspects of the project together.

University of Alabama at Birmingham – A Comprehensive Data Science Software Toolkit to Improve Alabama's Mobility Planning for Serving Businesses and Vulnerable Populations

This project focuses on the development of a comprehensive data science software toolkit to support transportation planning for Alabama's businesses and vulnerable populations. Research activities include: (i) use of transportation user surveys and open data source collection to build a web-based data portal for mobility analysis in Alabama; (ii) development of agent-based urban transportation simulation models, and employment of machine learning techniques for transportation forecasts; and (iii) use of the developed tools to study scenarios that address pressing mobility needs in Alabama. Examples include (1) building a COVID-19 simulator to explore how various business reopening strategies affect the population's mobility and hence the virus spread; and (2) studying the impact of shared mobility services such as Uber/Lyft/Via, Zyp BikeShare stations and dock less electric scooters on local traffic congestion, transit use; and accessibility and mobility of vulnerable populations. The project will provide helpful recommendations to transportation policy makers about transportation initiatives that can help Alabamians, including economically and physically disadvantaged ones, to gain access to jobs and critical amenities in an equitable and efficient manner.

During the reporting period of April to June 2021, the team completed the Uber survey design and planning process. As part of this effort, first we developed the Uber driver survey instrument in Qualtrics. The survey instrument will be used to collect a sample of Uber trips from local Uber drivers in order to better understand travel patterns in the Birmingham Metro region and

incorporate those into our simulation modeling efforts. As soon as the survey instrument was completed, we filed for IRB approval which is a necessary step prior to performing any research work involving human subject. The IRB application is currently under review. Moreover, we prepared guidelines to assist study participants with retrieving and uploading their historical trips into the survey. The team is also developing the proposed vehicle sharing simulation tool. MATSim's carsharing module has been adapted to incorporate various vehicle types such as bikes and e-scooters. As e-scooters from 'Veo' and 'Gotcha' have been deployed throughout the UAB campus recently, we are developing the simulation of on-campus traffic at UAB considering the mode of shared e-scooters, to study the impact of this new service. We have mostly completed the generation of student travel-plans from home/on-campus apartment to classrooms and verified that when using these plans as simulation input, the simulation results are realistic. We will incorporate employee travel-plans to make the simulation tool complete in the next reporting period.

Auburn University – Design, Fabrication and Testing of Novel Medical Facemasks to Prevent COVID-19

This research will focus on design, fabrication and testing of novel medical face masks to reduce and prevent spread of coronavirus COVID-19. Various woven, knitted and nonwoven fabrics and their combinations will be examined to be used in surgical face masks and N95 respirators. Computer aided design (CAD) of fabrics will be generated and virtually tested. After choosing the right fabrics based on these computer tests, prototypes of Surgical Face Mask Level 1 and N95 respirator will be produced. These masks will be tested against the ASTM (formerly known as American Society for Testing and Materials), Food and Drug Administration (FDA) and National Institute for Occupational Safety and Health (NIOSH) standards. Upon passing the tests, the technology and know-how that is developed will be used either in a start-up company or will be licensed to an existing U.S. commercial textile company to mass produce masks and respirators for public use in the next phase.

A new 3D additive manufacturing machine with two nozzles has been purchased and installed to produce plastic braces to keep the mask away from the mouth and nose, which is a new concept. Several new masks have been produced with novel features including retractable ear loops for easy handling of the mask. It was found that knitted fabrics provide better conformity to the face than woven fabrics as the outer layer of the mask. A website is under construction to disseminate the research results. The intellectual property disclosure that was filed has been expanded and updated.

Auburn University – Formaldehyde Paper-Based Device (PAD) for a Cost-Efficient Detection of Formaldehyde Emissions from Wood Panels

Formaldehyde emission can be toxic to people depending on the time of exposure coupled with formaldehyde concentration. This level of exposure is generally not high in forest products because companies that make indoor products currently measure formaldehyde through quality control techniques. Companies also use safe adhesives ("glues") by partnering with their suppliers. Nevertheless, these companies are regulated to federal standards such as the California Air Resources Board (CARB) to ensure this safety. To assist with the more expensive and laborious methods in CARB, this project endeavors to create a relatively cheap paper-based sensor that changes color based on formaldehyde exposure. Such a product can help to reinforce the safety of our forest products while maintaining the jobs of our many Alabamians.

The progress of the research work performed during the first quarter of 2021 meets the goals described in the project's timeline. Two polymers are being tested, and the preliminary data show positive results. Fast screening of the systems to be applied as fiber modifying agents has been conducted and the results are being analyzed. The team is currently working on the characterization of the systems. The experimental work will focus on the activities described as Activity 1 and Activity 2 on the project proposal for the upcoming quarter. Also, the calibration of the desiccator cabinet to be used for the accurate formaldehyde emissions (ASTM D6007-14 standard method) will be completed.

University of Alabama at Birmingham-Commercialization of Small Diameter Artificial Vascular Graft for an Animal Trial

The goal of the project is to finalize the development of an artificial vascular graft for surgical implantation. The graft has relevance to the current COVID-19 pandemic in that numerous patients are reporting kidney infections and blood clots. UAB has been working on this project since 2007 and has reached a point where funds are needed for an animal trial. Once this graft has been validated through this process, we plan to market it to a biomedical implant company to set up a division in Alabama or to establish a spin off company for the production and distribution. This graft has the potential for an estimated $50 million in annual sales based on conservative estimates of the number of surgical interventions that could use the implant in an unmet market and lead to a number of jobs for highly skilled workers in the State of Alabama.

The initial setup of the grant has been processed by ADECA and the University; and the final accounting process for distributing the funds to the departments is in process. We are preparing to order the equipment necessary to manufacture the vascular grafts and plasma and treat them in a sterile environment. We also will begin the process for ordering the animals for the trial.

Bashan Institute of Science – Exploring the Use of Cellulose Fibers as Microcapsules for Plant Growth-Promoting Bacteria (PGPB) Inoculants

Inoculation of plants with plant growth-promoting bacteria (PGPB) that enhance the yield of crops and growth performance of environmental plants is an old practice. Two main factors control the success of inoculation—effectiveness of the bacteria and application technology. If the suspensions of bacteria are inoculated into the soil without a proper carrier, the bacteria population declines rapidly. These unprotected inoculated bacteria must compete with the often better-adapted native microflora and withstand predation by soil microfauna. Consequently, a major role of formulation of bioinoculants is to provide a more suitable microenvironment, combined with physical protection for a prolonged period to prevent a rapid decline of introduced bacteria. During the second quarter we assessed the successful colonization of the fibers by the bacteria.

Overview of 2021 Program Year

- Applications were released March 1, 2021
- Applications are due July 29, 2021