Alabama Research and Development Enhancement Fund
Quarterly Report
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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 addresses a class of emerging contaminants, known as PFAS, which have been widely detected in chemical manufacturing wastes and landfill leachate in Alabama, and have caused serious cases of drinking water contamination in the state. Ongoing health concerns and regulatory development related to PFAS are threatening the sustainable development of business, which can substantially hurt the economy and thousands of jobs in the state. This research aims 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.

The project has made progress on two major tasks including preparation, characterization, and optimization of gallium-doped, carbon-supported titanate nanotubes (Ga/TNTs@AC) and testing the material for the removal and degradation of PFAS from water and leachate. The team has obtained an optimized recipe for preparing Ga/TNTs@AC, and found the Ga/TNTs@AC was able to rapidly and nearly completely adsorb PFOS (one of the major PFAS) from synthetic water, and then degrade 75.0% of the pre-sorbed PFOS, of which 66.2% was mineralized under UV light for 4 hours. These results preliminarily revealed the potential of the material and the proposed technology for cost-effective PFAS remediation.

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.

Auburn University – Advanced Biosensors from Forestry Products and Agricultural Resources

This project will focus on nanotechnology research and development efforts seeking to leverage Alabama's forestry products and agricultural resources to produce advanced biosensors comprised of nanocellulose. Nanocelluloses are contained in all biomass including forestry products and agricultural resources. States like Alabama that have significant timberland are the most likely to benefit from the projected growth in nanocellulose demand. This demand is contingent on ongoing research and development of nanocellulose applications such as biosensors. Regardless of the biomass source, nanocelluloses' high strength, absorbency and specific surface area make them attractive for a broad range of applications including packaging, specialty papers, composites, paints, pharmaceuticals, and biosensors. The research in this project will use nanocellulose obtained from forestry operations for biosensor production.

The Auburn University research team is exploring cellulose nanomaterials extracted from resources that are abundant in Alabama. To date, the focus has been on characterizing nanomaterials extracted from soybean and cotton. Different chemical schemes for modifying the nanomaterials' surfaces to enable the detection of carbofuran, a common pesticide, are being developed and compared. Work has also started on enabling the detection of □-lactoglobulin, a common allergen. In ongoing research, this initial work will be refined to better understand the chemistry and the potential for cellulose nanomaterials to be used as a sustainable alternative to current sensors.

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 both phases by establishing an ongoing recruitment effort with Auburn that has returned pharmacogenetic test results to more than 50 employees. We have also partnered with Miles College and East Alabama Medical Center for similar projects and will soon engage three more entities throughout the state.

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.

The phases of the project have been defined to be: Research Potential Impacts by Sector, Research and Development of the RSIR, Outreach, Engagement Process, and Engagement Execution. Progress this period has been focused on the "Research Potential Impacts by Sector." A detailed plan and schedule for this phase has been created and is being followed. Research and documentation of findings has been initiated. The team has been conducting research and documenting findings. Research resources include peer reviewed journals, industry publications, and other research studies and reports. The scope of the research includes identification and categorization of disruptive events by industry sector and categorization of business areas impacted by disruptive events. Initial activities have also been conducted to conceptualize approaches for the Resiliency and Sustainability Roadmap model.

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

The ADECA Office of Water Resources (OWR) "plans, coordinates, develops and manages Alabama's water resources, both ground and surface water, in a manner that is in the best interest of the state." The proposed project will address these unique challenges through 3 interconnected research tasks. Task 1 will update the existing manual center pivot irrigation survey completed by UAH for the years 2006, 2009, 2011, 2013 & 2015 to include 2017 and 2019. Task 2 will develop a machine-learning framework of remote sensing products to identify the irrigated areas in Alabama. Task 3 will review and update the report "Estimates of Future Agricultural Water Withdrawal in Alabama," produced by the Water Resources Center, Auburn University for OWR in 2017. 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.

Activities of the first quarter were to ensure the award was in place at UAH and facilitate the subcontract award at Auburn. We also were able to hire an undergraduate student at UAH and a graduate student at Auburn to begin the manual center pivot irrigation survey. Currently data is being downloaded from the USDA NASS website and organized to be shared between the universities. A project meeting is planned to kick-off the manual survey efforts. Additionally, UAH has brought on a graduate student to perform the machine learning tasks.

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 January 2021 to March 2021, the team has been working mainly on two tasks: (1) Uber driver survey design and planning, and (2) adding vehicle sharing support to our current transportation simulation pipeline. For Task 1, the Uber driver survey, the team has explored options for identifying and recruiting Uber drivers to participate in a survey that aims at capturing the travel patterns of Uber drivers in the region. We plan to use the anonymized survey to gather information related to trip origin and destination (concrete location anonymized), trip time requested, duration, and a screenshot of the small trip trajectory summary from the "Trip Details" page in their App. We will recover the approximate trajectory by comparing the screenshot with Google Maps. We are currently developing recruitment materials and plan to use the Qualtics platform for our survey. For Task 2, the vehicle sharing simulation, we have explored the functionality of the carsharing module of MATSim and gained an understanding on how it functions and its requirements and capabilities (e.g., parameters like a maximum search radius for walking to find a vehicle).

We have revised the MATSim Birmingham model code to introduce travel modes other than private cars, such as e-scooters and bikes with lower free-flow speeds. We have also collected the locations of various apartments where UAB students tend to rent, all the UAB classroom locations, and Zyp BikeShare stations to generate simulated trips. A preliminary simulation is under construction by generating realistic on-campus trips that incorporate vehicle sharing options. With the recent launching of e-scooters (Ride Fiik, Bolt Mobility) and bikes (Birmingham Shared Micromobility Program) in the city of Birmingham, we expect that on-campus trips using such modes will increase as UAB returns to normal business operations in the Fall. This will allow us to collect user attitudes and experiences using survey instruments to help adjust and evaluate our simulations.

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.

Two graduate students have been hired to work on the project. Various equipment and materials have been purchased. A multiuse prototype knitted facemask has been produced with a pouch for insertion of single use meltblown nonwoven fabric. Computer models have been developed for 3D printing of facemasks and several 3D printed facemasks have been produced using fuse deposition modeling (FDM) method. A journal article has been published for the literature review which is continuously being updated. An intellectual property disclosure was filed with Auburn University and a Spring Pitch was submitted to TechConnect Ventures.

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. The goal of this project is to explore the use of cheap cellulose fiber as carriers for PGPB. Considering the availability of the material in Alabama, as a leftover of the logging industry, it makes sense to explore its use for the development of novel PGPB bioinoculants destined to enhance crop production.

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Overview of 2021 Program Year

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