

Broadening Our Perspective: From Inspiration to Impact

RESEARCH HORIZONS
2021 ANNUAL REPORT





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TENNESSEE STATE UNIVERSITY PRESIDENT

DR. GLENDA GLOVER



OFFICE OF
THE PRESIDENT

December 8, 2021

TENNESSEE STATE UNIVERSITY
3500 JOHN A. MERRITT BOULEVARD
NASHVILLE, TENNESSEE 37209-1561



Dear TSU Friend and/or Stakeholder:

This year has created many challenges for all of us and we, as a University have succeeded in overcoming these obstacles and are emerging out of 2021 stronger than ever!

I am pleased to announce that the highest ever new research funding amount in Tennessee State University's history is \$70,729,452. This amount represents our resilience in the face of adversity. It demonstrates our willingness to work harder despite the obstacles of working from home, and the difficulties that come with not being able to access our laboratories. The pandemic did not stop us and it will not stop us! I am proud of those of you who are helping us grow as a research institution. Our goal is to become a Carnegie R1 Institution and to do so, we will need more faculty to take on the challenge of securing funded research. I know that submitting proposals can often be tedious and time-consuming, but I believe in you. Tennessee State University is a land-grant institution and part of our mission is that of teaching research and extension, which aligns well with our motto of "Think, Work and Serve".

I am excited about the future of our beloved Tennessee State University, and the opportunities we are providing our students. Please continue to stay safe and we will get to the other side of this pandemic together!

Sincerely,

A handwritten signature in blue ink that reads "Glenda Glover".

Dr. Glenda Glover
President

"Think • Work • Serve"

AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER M/F

ASSOCIATE VICE PRESIDENT FOR RESEARCH AND SPONSORED PROGRAMS AND
CHIEF RESEARCH OFFICER

DR. FRANCES WILLIAMS



"Think. Work. Serve."

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Office of the Vice President

Greetings,

This report highlights the scholarly accomplishments of our world-class researchers at Tennessee State University (TSU). Our researchers are making new discoveries and developing solutions to global challenges. In this report, you will read about some of their work, including the work of one scholar to develop tools and technologies to strengthen the security and resilience of critical transportation infrastructure and the work of another scholar to lead a national effort to develop tools to manage a woodboring beetle that attacks trees.

Further, during the past year, Tennessee State received a record number of awards for research and sponsored programs. TSU received \$70.7 million in grants and contracts from various funding agencies and sponsors, surpassing the University's previous record of \$55.2 million. This increase in grant awards shows the commitment of our faculty and staff to scholarly achievement even during the pandemic. Further, it illustrates the growth and progression of TSU as a research institution (R2: Doctoral University – High research activity in the Carnegie Classifications for Institutions of Higher Education). In addition to our increased research awards, during FY21, TSU faculty and staff also submitted the highest number of proposals (221 proposals) to various funding agencies.

I commend our faculty, staff, and student researchers for their research achievements, despite the many challenges that were present during FY21. I am excited about the broad impact their discoveries and innovations will make in improving communities, locally and globally.

Sincerely,

A handwritten signature in cursive script that reads "Frances Williams".

Frances Williams, Ph.D.
Associate Vice President for Research and Sponsored Programs



Tennessee State University is an AA/EEO employer.

RESEARCH CENTERS AND INSTITUTES

Research Centers and Institutes at Tennessee State University

Center for Aging: Research and Education Services (CARES)

Center for Entrepreneurship and Economic Development (CEED)

Center for Prevention Research

Center of Excellence for Battlefield Sensor Fusion

Center of Excellence for Learning Sciences (COE-LS)

Center of Excellence in Information Systems Engineering and Management (COE-ISEM)

Cooperative Extension Program (CEP)

Institute of Food, Agricultural, and Environmental Research (IFAER)

Institute of Government

Nanoscience and Biotechnology Core Facility

Otis L. Floyd Nursery Research Center at McMinnville

TSU Interdisciplinary Graduate Engineering Research (TIGER) Institute

- Advanced Visualization and Computing
- Bioinformatics
- Cybersecurity
- Mechatronics
- Nano-materials
- Renewable Energy Systems



Agricultural Biotechnology Building



Otis L. Floyd Nursery Research Center in McMinnville, Tennessee



Health Sciences Building

UNIVERSITY RESEARCH CAPACITY

Founded in 1912, Tennessee State University (TSU), a Historically Black College and University (HBCU), fosters scholarly inquiry and research, lifelong learning, and a commitment to service. This 1890 land-grant institution with three farms is Nashville's comprehensive public university, as well as a **Carnegie R2 Doctoral – High Research Activity** institution. TSU has demonstrated expertise as a robust, expanding educational and entrepreneurial research engine with a continuous positive impact on the economic ecosystem of Nashville, the State of Tennessee, regionally and nationally. Through a myriad of collaborations and an interdisciplinary approach, the university offers unique research, creates entrepreneurial opportunities, produces workforce ready talent, and provides educational and technical assistance services to students, scholars, industries, communities, and business partners.

Strategic Research Priorities

Tennessee State University delivers solutions from local to global challenges through strategic priority areas.

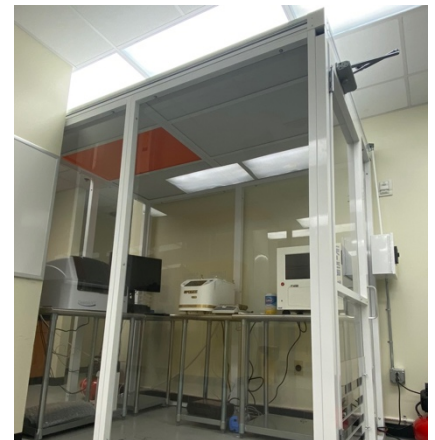
1. Cybersecurity, Cyber Physical Systems, Bioinformatics, & Interoperability
2. Renewable Energy
3. Big Data Analytics
4. Education Innovation and Leadership
5. Food Supply Security and Sustainability
6. Plant and Animal Genetics
7. Health Disparities and Disease Prevention/Treatment
8. Workforce Pipeline Development
9. Early Childhood Education
10. Rural Economic Development and Urban Planning
11. Biotechnology, Nanosciences, and Advanced Materials
12. Astrophysics
13. Transportation Systems
14. Advanced Manufacturing
15. Autonomous Vehicles
16. Robotics and Mechatronics

Research Methods and Techniques

The university offers an array of techniques, approaches, methodologies, and services for solving the world's most pressing issues and providing assistance to communities. Common approaches used include Feasibility Studies, Economic Impact Modeling, Simulation Testing, Prototype Development, Data Mining, Trend Analysis, Market Analysis, Stress Testing, Automatic Target Recognition Testing, Learning and Behavioral Assessments, Confocal Imaging, Needs Assessments, etc.

For more information contact:

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The Nanotechnology Laboratory is the home of a new ridged-walled modular cleanroom. Six new micro and nano fabrication tools were installed, including a Bruker Dektak XT Profilometer.

TSU QUICK FACTS: 2020 - 2021



Carnegie "High Research" University (R2)



395 Full-time Academic Faculty



Undergraduate Student-to-Faculty Ratio: 16 to 1



83 Majors in Eight Undergraduate and Graduate Colleges and Schools



520 Campus Acres, Two Campuses, Three Farms



Fall 2020 Undergraduate Student Enrollment: 6,000



Fall 2020 Graduate Student Enrollment: 1,615

COLLEGES OF THE UNIVERSITY

College of Agriculture Department of Agricultural and Environmental Sciences/Department of Human Sciences

The faculty of the College of Agriculture are engaged in conducting innovative research and communicating new knowledge through Extension activities in the agricultural and environmental sciences and human sciences. The College of Agriculture addresses the needs of humankind, focusing on finding solutions to challenges faced by socially and economically disadvantaged groups, and contributing to the prosperity of the citizens of Tennessee, the nation, and the world. Research areas include agricultural economics and rural communities; agriculture systems and technology; animal health, production, and products; bioenergy, natural resources, environment; food safety, nutrition, and health; plant health, production, and products; family well-being and youth development.

College of Business

The College of Business (COB) is uniquely poised as a strong, robust, and expanding educational options with the Accelerated and Executive MBA programs. These graduate programs provide convenient and flexible options for working individuals and students taking the next step in management. Preparing students for the corporate environment or entrepreneurship, the COB is positively impacting the entrepreneurial and economic tapestry of Nashville, the State of Tennessee, and the world. The faculty are engaged in conducting applied, discipline-based, and pedagogical research in accounting, business management, economics, finance, and information systems and technology. Our graduates are well prepared and highly sought after. TSU's College of Business is proud to be a part of Nashville's business ecosystem.

College of Education

The College of Education faculty are engaged in research that examines disparities in education and student learning. They strive for developing, and implementing, innovative models of programs, instruction, and assessment along with integrating technology to influence student learning outcomes; elevating teaching and leading; designing clinical experiences to transform human capital pipeline, developing strategic partnerships; using data to inform program development, and applying human capital decision making processes; strategies for developing pathways to excellent teaching; and more inclusive models of student academic success that are designed to impact student retention.

College of Engineering

The College of Engineering faculty are conducting research in nanomaterials, signal and image processing, intelligent control systems, robotics and mechatronics, artificial intelligence, bioinformatics and big data, health monitoring, systems engineering, wireless communication, and cybersecurity across various systems and software. Our engineering programs house masters and Ph.D. degree opportunities.

College of Health Sciences

The faculty of the College of Health Sciences, our largest college, are engaged in conducting research that includes speech pathology and audiology, behavioral science approaches to reduce health disparities, obesity, diabetes, and breast cancer prevention and treatment. The COHS is housed in our new 100,000 sq. ft. facility completed in November 2020 with all new equipment and labs. The college also houses the Tiger Community Rehabilitation Clinic, a student-run occupational and physical therapy clinic that

COLLEGES OF THE UNIVERSITY

is free to the public. The TSU downtown campus is the home of the Tennessee State University Speech and Hearing Clinic which works with children, seniors, stroke victims, and many others in the Middle Tennessee region.

College of Liberal Arts

The faculty of the College of Liberal Arts are engaged in conducting research in areas that reflect knowledge and potential of new interdisciplinary fields while continuing work in the traditional academic disciplines at the heart of a university. The research includes studies in geosciences and environmental justice; global perspectives on civil rights and justice issues; African American history, literature, and culture; education in music, history, literature, and language; global perspectives in art; and criminal justice.

College of Life and Physical Sciences Department of Chemistry

Research from the faculty of the Department of Chemistry is focused on environmental science, cancer, viruses, drug design, the synthesis of novel inorganic materials, and the interactions between different biological systems and membrane constituents.

Department of Biological Sciences

The faculty of the Department of Biological Sciences are engaged in research endeavors in the broad area of cellular and molecular biology. Research activities involve studies of the COVID19 virus, sustainable biomaterials, environmental biology, plant extracts and the effect of cancer cell growth and function, studies of the role D3 receptors play in neuronal development, studies of collagen assembly and trafficking, and studies of global change ecology.

Department of Mathematical Sciences

Research interests from the faculty of the Department of Mathematical Sciences include applied mathematics, mathematical modeling, functional and numerical analysis, algebra, mathematics education, wavelets, physics, and astronomy.

University Honors College

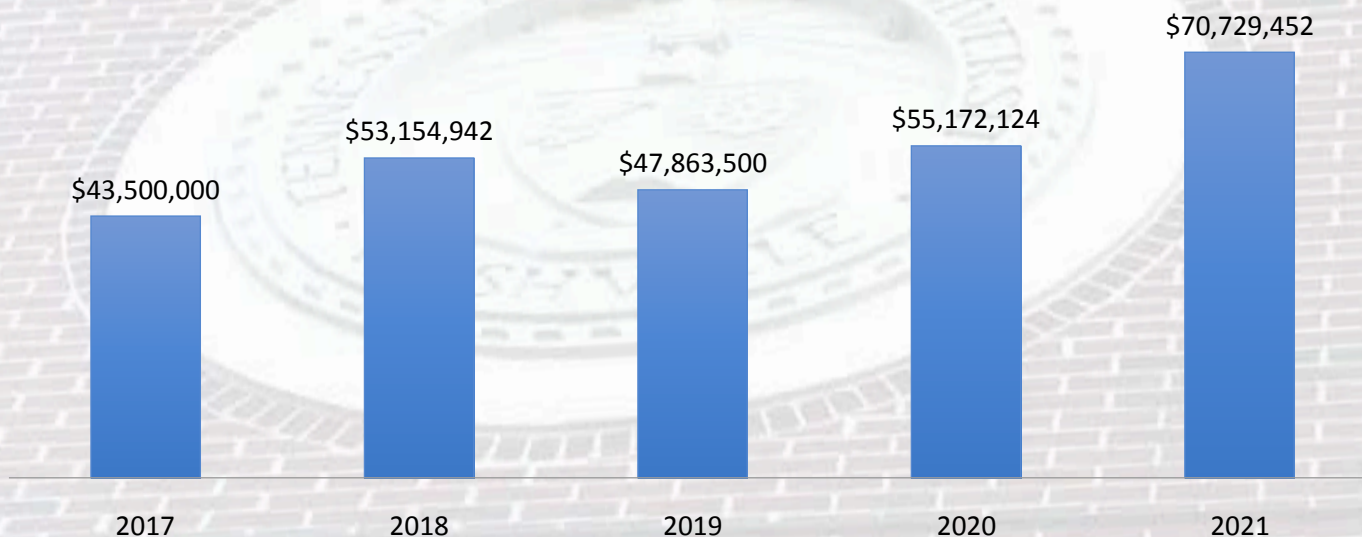
The University Honors College (UHC) provides an especially rich and challenging set of academic offerings to talented and highly motivated students at Tennessee State University. Through special courses, a vigorous intellectual community, and emphasis on undergraduate research, the Honors College enables students to reach new heights of excellence!

College of Public Service

The faculty of the College of Public Service are engaged in conducting research specific to leadership; intergovernmental relations, public finance, public policy; policy and economics of education; environmental policy and justice, urban planning and policy, economic development, gentrification, non-profit management and community revitalization; public administration and policy analysis; state lottery policy; health policy; social work; and aging.

RESEARCH AWARDS: 2020 - 2021

Annual Research Awards: Five-Year Results



High-Impact Funding Success

RECORD FUNDING



More than \$70 million in external funding during the 2020-2021 fiscal year

RECORD SUBMISSIONS



Faculty and staff submitted 221 proposals, the highest in University history

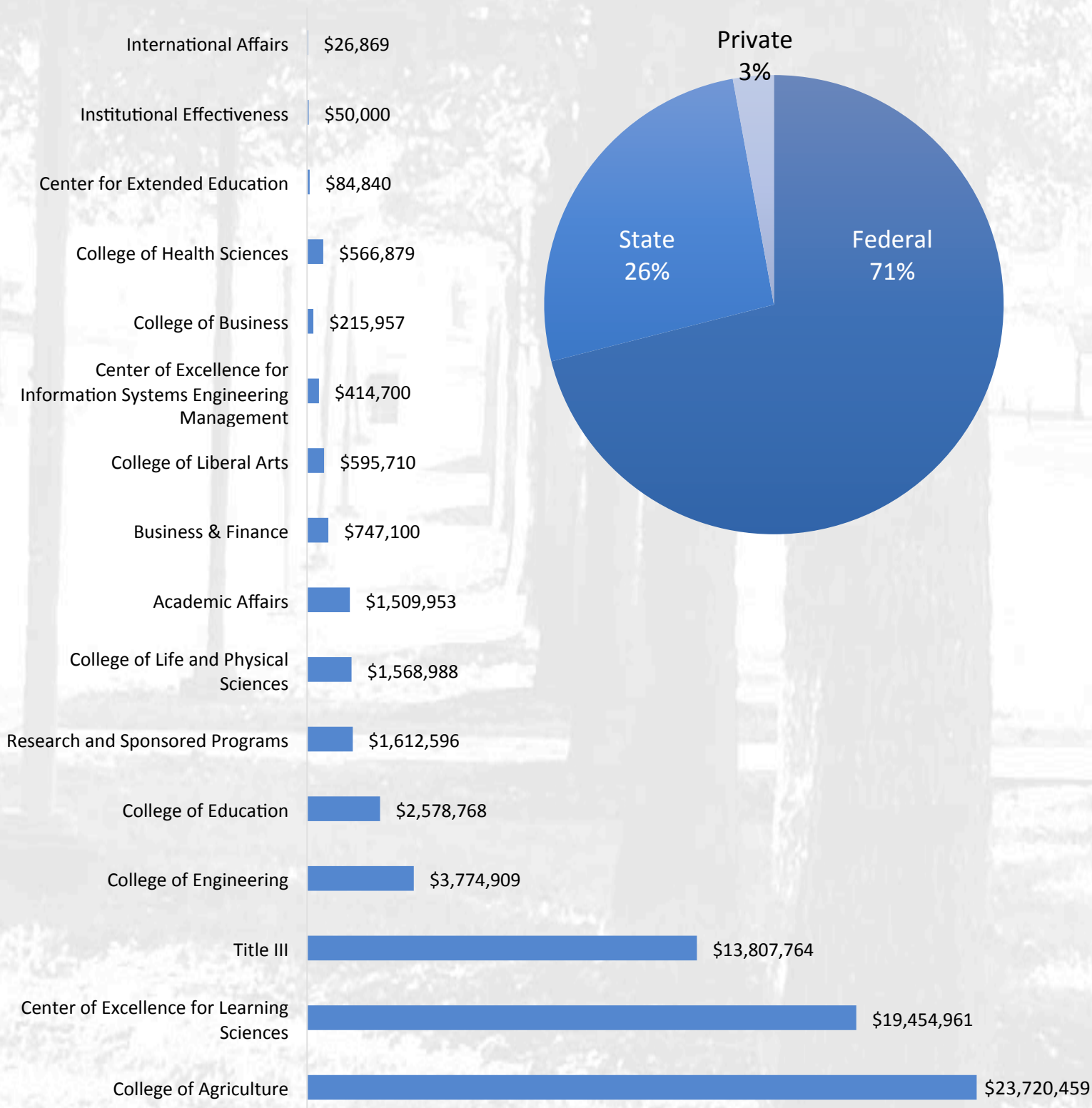
63% INCREASE OVER FIVE YEARS



63% increase in funding from 2017 to 2021

RESEARCH AWARDS: 2020 - 2021

2021 Awards by College, Division, or Center



FACULTY RESEARCH HIGHLIGHTS

ASSOCIATE PROFESSOR

DR. KARLA ADDESSO

Discovering Best Practices for Pest Management

Breakthrough advancements in the technology that increase crop production often begin by studying their insect pests. Flatheaded borers (Coleoptera: Buprestidae) in the genus *Chrysobothris* are serious pests of nursery, tree nut and fruit crops. Females lay eggs in the trunks of trees and larvae feed on the vascular tissue, disrupting water and nutrient movement. Attacks cause trunk scars, bark shedding and splits, suckering, sap leakage, crown dieback, and tree death.

Dr. Karla Adesso leads a multi-state team of 23 researcher labs tackling management of flatheaded borers in specialty tree crops. These crops are vitally important to the economy, accounting for millions of jobs and billions of dollars in national economic impacts. This project, funded by the USDA Specialty Crop Research Initiative (SCRI) for \$6 million, began in the fall of 2020 and, despite the pandemic and its challenges, the research team was able to recruit students, postdoctoral researchers, and technicians and initiate field projects in Tennessee, North Carolina, South Carolina, Georgia, Florida, Texas, Alabama, California, and Oregon. This is the first year of the four-year project. The long-term goals of this project include the development of comprehensive best practices for the production

and management of flatheaded Borer host plants, mitigating conditions that promote attacks, and identifying the most effective chemical and biological tools.

Dr. Adesso is an Associate Professor in the College of Agriculture. She received her PhD in Entomology from University of Florida and was awarded the Henry and Sylvia Richardson Postdoctoral Award by the Entomological Society of America in 2009. Her research focuses on management of woody ornamental pests in nursery production and landscape. Since joining TSU in 2012, she has won the College of Agriculture Young Researcher Award, mentored 15 graduate students, two postdoctoral associates and published several dozen peer-reviewed, extension, and trade papers.

Dr. Adesso has served the Entomological Society of America in several roles over the years, most recently as the SE Branch Representative to the Governing Board. She is active in the Tennessee Entomological Society, serving previously as Member-at-Large, Proceedings Editor, Publicity Chair and President. Dr. Adesso is an Associate Editor of *Environmental Entomology* and serves as a reviewer for other ESA and topical journals.



Dr. Karla Adesso is an Associate Professor in the Department of Agricultural and Environmental Sciences at Tennessee State University.



The Flatheaded Borer (Coleoptera: Buprestidae) in the genus *Chrysobothris*.



Field projects include the evaluation of cover crop and barrier products for reducing borer incidence, conventional insecticide trials and timing studies, and the investigation of different production stressors as causes of attacks.

FACULTY RESEARCH HIGHLIGHTS

ASSOCIATE PROFESSOR

DR. ALIYAR FOULADKHAH

Improving Food Safety and Security in a Changing Climate

While much attention has recently been devoted to public health and preventing the spread of respiratory viruses, illnesses derived from food and water-borne pathogens continue to be an ongoing threat to food production, consumption, and living environments. This makes microbiology research an important field of study, especially with relation to the differential impacts of climate change.

Dr. Aliyar Fouladkhah is an Associate Professor in the Department of Agricultural and Environmental Sciences and Faculty Director of the Public Health Microbiology Laboratory. The main foci of Dr. Fouladkhah's laboratory endeavors are for better understanding ecology, epidemiology, pathogenesis, and control measures against environmental and enteric pathogens and spoilage organisms, especially those that are non-vaccine preventable in nature.

In research published in 2021, the research team studied the presence of biofilm formation of three bacteria in surface water, concluding that without additional treatments, contamination in water supplies can lead to prolonged survival of these pathogens. Dr. Fouladkhah and his team also investigated foodborne pathogens Shiga

toxin-producing *Escherichia coli* (*E. coli*) and *Listeria monocytogenes* and determined effective pressure-based pasteurization and decontamination methods. The research group's recent publication suggests interventions that could be used during and after infant formula manufacturing could minimize the risk of contamination with *C. sakazakii*, a bacterium that thrives in dry environments, such as powdered infant formula.

Dr. Fouladkhah is currently leading a project funded by Pressure BioScience Inc. investigating "Pressure-based inactivation of bacterial spores and pathogenic organisms" and a project funded by the USDA National Institute of Food and Agriculture entitled "Assisting Producers and Processors Meeting Water and Food Safety Requirements of Current Regulatory Climate." Since joining the Tennessee State University faculty in 2015, Dr. Fouladkhah has secured over \$3.5 million in extramural funding.

Dr. Fouladkhah is an alumnus of Colorado State and Yale University, a Certified Food Scientist of the Institute of Food



Dr. Aliyar Fouladkhah is an Associate Professor in the Department of Agricultural and Environmental Sciences and Faculty Director of the Public Health Microbiology Laboratory at Tennessee State University.



Students Sabrina H. Wadood (center left) and Sadiye Aras (center right) won first and second place in the oral and poster events at the 2021 Tennessee Academy of Science competitions.

Technologists, an Inducted Member of the American College of Epidemiology, and is certified in Public Health by the National Board of Public Health Examiners.

FACULTY RESEARCH HIGHLIGHTS

PROFESSOR

DR. DEO CHIMBA

Improving Transportation during Catastrophic Events

Dr. Deo Chimba is a Professor in the Department of Civil and Architectural Engineering. He has secured more than \$3,000,000 research grants since joining Tennessee State University in 2010. With his research interests in transportation systems, Dr. Chimba's research is housed at Transportation Engineering, Planning and Safety Lab (TEPS-Lab) at Tennessee State University.

Dr. Chimba is the Principal Investigator of active \$470,000 Department of Homeland Security (DHS) project titled "Transportation Resilient Under Catastrophic Events (TRUCE)". The project develops a research and education initiative at the department of civil and architectural engineering TSU that fosters interdisciplinary research and education in two DHS-strategic plan goals: (1) strengthen preparedness and resilience and (2) workforce development. The project is motivated by the challenges of using transportation systems in emergency preparedness and response during natural and man-made incidents. The project research focuses on developing tools and technologies that strengthen the security and resilience of critical infrastructure, safeguarding the United States transportation system, with desired outcomes that include extreme disaster preparedness, enhancement of public safety and property protection, and quick and

decisive responses during catastrophic incidents to reduce their impacts.

Dr. Chimba as the Principal Investigator is currently conducting a feasibility study that is evaluating the potential of converting the existing HOV lanes in Tennessee to HOT lanes as part of TDOT's managed lane strategies. This \$205,000 Tennessee Department of Transportation (TDOT) sponsored project titled "Comprehensive Analysis on The Conversion of the Existing HOV Lanes into HOT Lanes in Tennessee" is anticipated to provide congestion relief, travel time reliability, and improve air quality. The study seeks to develop an understanding of the perceptions and preferences of stakeholders regarding HOT lanes. HOT lanes are HOV lanes that allow vehicles that don't meet occupancy requirements to pay a toll to use the lane. Variable pricing is used to manage the lane so that reliable performance is always maintained. This is a second HOV related study which Dr. Chimba as the PI is conducting for TDOT following another \$157,000 concluded in 2018 that evaluated Tennessee's HOV system performance to address high violation rates due to the high volume of traffic on freeways. The study evaluated HOV lane utilization, HOV lane occupancy violation rates and performed stakeholder/public surveys.



Dr. Deo Chimba is a Professor in the Department of Civil and Architectural Engineering at Tennessee State University.



The TEPS-Lab comprises both graduate and undergraduate students conducting research in various topics related to Transportation Systems including traffic analysis, modeling and simulations, highway safety analysis and modeling, public/transit, bicycle and pedestrian, transportation incident management and application of statistics in transportation.



Understanding the Science of Learning

We believe there is an ideal experience for individuals to master learning at every stage of life.

STATEWIDE SERVICES

COELS delivers training and services for the state of Tennessee through the Tennessee Early Childhood Training Alliance (TECTA), the Tennessee Family Child Care Network (TFCCN), the Tennessee Early Childhood Program Administrator Credential (TECPAC), and the Social Services Competency Based Training (SSCBT) program.

DIRECT SERVICES

COELS provides direct services to children and their families through the Tennessee CAREs Early Head Start and the Tennessee State University Early Head Start-Child Care Partnership programs. The programs are designed to provide successful health, economic and educational outcomes, and long-term academic success for children.

ONLINE DELIVERY

COELS helps innovate online training for child care providers in Tennessee through the Tennessee Childcare Online Training System (TCCOTS), the Tennessee Professional Archive of Learning (TNPAL) and the TrainTN online registry. We also continuously revise our hybrid and in-person training and service delivery to accommodate today's learners.

For more information visit www.tnstate.edu/learningsciences
or contact Dr. Kimberly I. Smith, Director • ksmith81@tnstate.edu
TSU Main Campus • Research and Sponsored Programs Building • Suite 1B



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