FY 2020 Annual Report of Accomplishments and Results

Alabama
Alabama A&M University - Extension
Alabama A&M University - Research
Auburn University - Extension
Auburn University – Research
Tuskegee University - Extension
Tuskegee University - Research

I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your FY 2020 Plan of Work located in the Institutional Profile. Use this space to provide updates if needed.

1. Executive Summary (Optional)

In March 2020, Alabama Governor Kay Ivey issued a statewide shut down due to the World Health Organization's (WHO) declaration of a global pandemic of COVID-19. As a result of the issued order from the governor's office, all 3 land grant universities were forced to pivot in implementation of teaching, research, and Extension programs. Adjustments were made to convert the majority of face-to-face meetings, trainings, and related activities to online or virtual formats as much as possible, while maintaining continuity of inputs and outputs from various sources.

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Process	Updates ONLY
1. The Merit Review Process	No update.
2. The Scientific Peer Review Process	No update.

III. Stakeholder Input

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Stakeholder Input Aspects	Updates ONLY
1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation	No update.
2. Methods to identify individuals and groups and brief explanation.	No update.
3. Methods for collecting stakeholder input and brief explanation.	No update.
4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.	No update.

IV. Critical Issues Table of Contents

No.	Critical Issues in order of appearance in Table V. Activities and Accomplishments
1.	Global Food Security and Hunger
2.	Food Systems and Food Safety
3.	Natural Resource and Environmental Sustainability
4.	Human Nutrition, Well-being, Health and Obesity
5.	Community Development
6.	Family, Home, and 4-H and Youth Development
7.	Sustainable Energy

V. Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). In your outcome or impact statement, please include the following elements (in any order): 1) the issue and its significance (e.g. who cares and why); 2) a brief description of key activities undertaken to achieve the goals and objectives; 3) changes in knowledge, behavior, or condition resulting from the project or program's activities; 4) who benefited and how. Please weave supporting data into the narrative.

No.	Project or Program Title	Outcome/Impact Statement	Critical Issue Name or No.
	AAMU Extension: Animal Science: Small Ruminant Extension Demonstration Program and Series	**Brief Description:** Over the past year, a research and Extension demonstration site was established to demonstrate to landowners and small ruminant producers the benefits of integrating goat production with forestland management. A virtual field tour and 3 sessions on small ruminant production systems were delivered to different audiences. **Outputs/Impact Statements (Results):** Post- session survey results indicated that 80% of forestland owners who attended sessions were convinced to bring goats onto their property, and 90% of attendees indicated that they were planning to implement what they learned during the session on their farms. Additional resources were provided including 70 books and 120 handouts. Also, 5 Extension articles on small ruminant	Global Food Security and Hunger (#1)

		production and management were published on the Alabama Cooperative Extension System (ACES) website. Two videos and 15 photos were also uploaded onto Facebook. This program reached 398 people. The Facebook posts and web page information on small ruminant production were viewed 2,272 times.	
	AAMU Research: Development of Epigenetic Resources for Reniform Nematode Tolerant and Susceptible Genotypes of Cotton	**Brief Description:** In the southern United States, Reniform nematode (RN) has become a major pest feeding on cotton roots with an estimated yield loss ranging from 10% to 100%, impacting US position in the global cotton trade and reducing the profitability of cotton growers and domestic textile industry. Such abiotic stress leads to wounding response, membrane disorganization, ion influx, generation of reactive oxygen species (ROS), xenobiotic stress, cell death, hypersensitivity response, altering gene networks and epigenetic mechanisms in the host. These responses vary significantly between susceptible and tolerant cultivars. The genes and genome of the reniform nematode were not fully known. **Outputs/Impact Statements (Results):** This project so far supported four undergraduates and two graduate students interested in STEM programs, emphasizing plant biology and genetics. The broader impact will be in the training of underrepresented students. So far, we have trained two graduates (MS-level) students and three undergraduate juniors in the advanced STEM areas, i.e., genomics and bioinformatics. More specifically, we trained graduate students with next-generation sequencing technologies, followed by processing data with bioinformatics. This proposal adds new dimensions in molecular research at AAMU by incorporating epigenomics and bioinformatics into our existing program. The research has also improved our understanding of the genes that regulate biological processes, how this parasite invades the cotton root cells and how best to identify weaknesses in its life cycle or metabolism that can be utilized in controlling it and resulting in improved cultivars/varieties of cotton. We recruited three graduates (MS-level) and four undergraduate students to undertake the project goals and to achieve all three objectives. In the first three years (FY2017; FY2018; and FY2019), we completed sample collection and processing, quality check, library preparation, and sequencing, and data analyses from both unstressed and stressed samples, later two years (FY2020 and FY2021), we analyzed and characterized selected genes from cotton transcriptome and regulation data, which resulted in two publications.	Global Food Security and Hunger (#1)

	AAMU Research: Minimizing stress and improving performance of grass-fed beef cattle	**Brief Description:** Several stressful factors including summer heat and weaning can affect cattle health and performance. With global warming as a consequence of climate change, heat stress particularly in the summer months continues to pose a severe challenge to beef cattle producers in Alabama and other parts of the southeast US. The study was designed to generate valuable information on cattle behavior and response during summer heat stress and weaning, and to evaluate the ameliorative effects of melatonin on stress responses. Overall, the information generated could help producers improve animal welfare and minimize stress in grass-fed beef cattle. The adoption of activity monitoring systems in combination with assisted reproductive technology is a unique approach to generating beef cattle behavioral data needed to fine-tune management strategies for improved beef cattle welfare. **Outputs/Impact Statements (Results):** Significant progress has been the following: 1) recruitment and ear tagging eligible animals for the study; 2) installation of an activity monitoring system for recording cattle lying behavior; 3) acquisition of melatonin implants and applicator and 4) provision of hands-on large animal experience for five animal bio-health science undergraduate students comprising several aspects of beef cattle management. We will continue to validate the data from the activity monitoring system in preparation for the field experiment scheduled to commence in the summer.	Global Food Security and Hunger (#1)
	AAMU Research: Bioavailability of Phytochemical and Antioxidant derived from Enzymatic Hydrolyzed Canned Red Kidney Beans (Phaseolus vulgaris L.) in the GIT	**Brief Description:** Phytases are enzymes that reduce the phytic acid content and increase the bioavailability of nutrients. RKB has also gained attention due to its antioxidant properties. Hence, the objective of this study was to determine the effect of enzymatic hydrolysis on the phytochemical content in hydrolyzed canned RKB subjected to in vitro simulation digestion. The RKB was canned in brine solution at different enzyme concentrations (0 and 200 FTU). The RKB samples were subjected to oral (OP), gastric (GP), and intestinal phase (IP) digestion. Total phenolic content (TPC), total flavonoid content (TFC), and antioxidant activities using ferric, reducing antioxidant potential (FRAP) and 1,1-diphenyl-2-picrylhydrazyl (DPPH) were determined. **Outputs/Impact Statements (Results):**	Global Food Security and Hunger (#1)

		The results show that the TPC (294.493 mg GAE 100 g-1 DM) and TFC (770.70 mg CE 100 g-1 DM) were significantly ($p < 0.05$) higher at the OP when higher enzymatic concentration (200 FTU) was used. In the GP, the TPC (205.788 mg GAE 100 g-1 DM) and TFC (551 mg CE 100 g-1 DM ($P< 0.05$) were observed at 200 FTU for OP, GP, and IP. The results obtained from this study confirmed that hydrolyzed RKB are excellent sources of flavonoids and phenolic compounds and the enzymatic hydrolysis process increase the antioxidant content in RKB. Target Audience: Undergraduate and Graduate Student, Research Scientists, Food industry, particularly the functional food manufacturers.	
	AAMU Research: Evaluating the Potential for Small Ruminant Production in Silvopasture and Open Pasture Grazing Systems in North Alabama.	**Brief Activity Description:** The project focuses on increasing the sustainability of pasture-based meat goats and sheep production in a loblolly pine based silvopasture system and conventional open grazing system in North Alabama. The project aims to increase the productivity and quality as well as extend the production duration of traditional warm season pasture sustainably to lower production costs and increase profits. **Outcome/Impact Statement (Results):** In five years, several consecutive grazing periods were successfully completed. The activities of this project included sharing knowledge obtained with the Alabama Cooperative Extension System. For instance, in 2016, a workshop was attended by more than thirty goats and sheep producers from the region in which feedback were positive. Presentations informed the attendance on how to retain a flow of annual income from agriculture while they are growing trees for timber by raising goats and sheep. During the last five years, over 300 animals (sheep and goats) were used to achieve the project's objectives. In 2019, the productivity, quality, and production when sheep and goats graze together (multi-species grazing) had been evaluated. The following results have been found: (1) No significant difference in the percent weight gain in sheep; (2) No significant difference was found in the percent weight gain in goats. Efforts will be made to conduct additional studies in the future.	Global Food Security and Hunger (#1)
	AAMU Research: Marketing and Socioeconomic Factors of Organic Farms: Age as a Predictor of Acceptance of Organic	**Brief Activity Description:** The target audience consisted of landowners and farmers, business owners and managers particularly of groceries and supermarkets that sold fresh foods and the general public who were made aware of the importance of quality foods and	Global Food Security and Hunger (#1)

	Food Products Alternatives among Metropolitan Population in Alabama	fresh food intake and their relationship to the health and food processor and food industry. Students, researchers were also targets of the information. **Outcome/Impact Statement (Results):** Oluwoye, J. (2019). "The Significance of Consumer's Educational Level and Other Sources of Motivation Towards Attitude to Organic Food Products: A Case Study of Riverdale, Georgia". CPQ Nutrition Journal, 3:5, September 2019. The above-published paper focused on knowing the significance of consumers' years of educational level completed and other sources of motivations towards consumers' attitudes to organic food products among samples of Riverdale residents in Georgia, United State of America. It should be noted that consumers' educational level is proportionately related to buying more organic products if they were less expensive and, ever been on an organic farm also negatively affects buying more organic products if they were less expensive. Furthermore, increases in educational level and buy more organic products if they were less expensive are other sources of motivation that positively affect the attitude towards organic food products. Policymakers should pay close attention to promoting awareness and consciousness levels and promoting the health benefits of organic foods in order to stimulate real purchasing actions. The findings of this study have important implications for the organic stakeholders, farmers, and the food industry in general.	
	AU Extension: Sustainable Livestock Systems Program	**Brief Description:** 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) focused on best land-animal management practices to enhance on-farm sustainability. Activities include: 1) Production/current topic meetings (such as, but not limited to, drought, climate, forage and feeding implications for livestock), 2) Meeting series (i.e., new and beginning farmer programs, production management series, etc.), 3) Demonstrations related to animal management concepts, 4) Conferences, 5) Field Days and Hands-On Learning Programs (on-farm and at experiment stations), 6) Profit Profiles, 7) Livestock enterprise budgets,	Global Food Security and Hunger (#1)

		8) Educational curriculum - quick reference content pieces, ANR publications, PowerPoint presentations, magazine articles. 9) Educational videos (YouTube and other short information pieces), 10) Social media outreach (Forage Focus and Beef Systems Facebook page and associated Twitter accounts). 11) Online decision tools and curriculum (Blogs, e-newsletters, websites, Beef Basics Online Course, and other e-learning platforms). **Outputs/Impact Statements (Results):** Assessments reported below were collected through: 1) web use metrics 2) post-program surveys associated with each respective program. Web-based educational resources have continued to grow in their use by Extension agents and livestock producers. There has been a more concentrated effort to develop both online and in-print resources for use by stakeholders to address on-farm livestock-forage management questions, especially amid the COVID-19 pandemic. Online resources offered through the Sustainable Livestock Systems Program reached an estimated 9,974 contacts in 2020. This is a 33% increase in the use of web-based resources by clientele for this program since 2019 and demonstrates the effectiveness of using a multi-tiered approach to offering educational resources to forage-livestock producers. There is increasing interest in forage-livestock programs from new and beginning farmers (<10 years' experience). Educational programs designed for producers with limited experience in livestock production reached new clientele with 55% of the participants (n = 75 people) indicating this was their first time attending an Extension program. Return on investment for flagship programs such as the Beef Basics online course, Beef Systems Short Course, and the Systems 360 discussion group program had a return on investment ranging 6:1 to 30:1.	
	AU Extension: Alabama Beginning Farmer Program (BFRD)	**Brief Description:** The Alabama Beginning Farmer Program (grant-funded by two major USDA and several smaller SARE grants) is an intensive educational and capacity-building program that has a team of Extension Specialists, Extension Coordinators, and Regional Extension Agents from five PPTs collaborating on content development, delivery, instruction, and evaluation. Overall objectives for the first phases of this program were:	Global Food Security and Hunger (#1)

		1) Establish a statewide network of Extension educators, and Technical Assistance Providers (TAPs are external contractors trained by state agencies) to benefit new producers. 2) Provide on-farm support services to new farmers through vast collaborations; and 3) Develop a uniform educational infrastructure for training producers through diverse communication channels that is all-inclusive and accessible (ADA compliant). Phase-2 of this major program will continue to expand digital and print educational materials, on-farm services, establish a Farmer Community Clusters and Mentor Farm Network over the next three years. REAs along with four nonprofit agencies and Technical Assistance Providers (TAPs) collaborate closely for program implementation at the county level. 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. **Outputs/Impact Statements (Results):** Innovation: Survey QR code printed on business card for scanning and entering data via smart phones. Responses in database (2019) = 42 cases. Client groups (major): 43% beginning (11% veteran farms), 35% experienced, 6% nursery & landscape, 16% community gardeners/urban farms. Percent crop improvement = 10 to 50% (2 respondents). Total reported impacts = $744,850 (28 cases). Estimated ROI = 55:1 ROI is rising as beginning farmers become established producers and expand their operations. Over 120 beginning farmers and experienced producers are part of the network that receives direct assistance from program coordinator (Ayanava) and other Extension Specialists, Regional Extension Agents (multi-teams), County Extension Coordinators (some counties), and the technical Assistance Providers (TAPs that are subcontracted via grants supporting the Alabama Beginning Farmer Program). The program initially received funding (past and ongoing) equivalent to $1.4 million with another $500,000 leveraged by Extension	

		Specialists and new faculty that depend on BFRD program resources as their communication and marketing platform.	
	AU Extension: Herbicide Stewardship and Application Education	**Brief Description:** The objective of this project is to 1) educate row crop producers, pesticide applicators, crop consultants, government agency employees and chemical dealers about herbicide injury, application requirements, new herbicides and new techniques for weed control, and best management practices to reduce herbicide drift and off-target injury, etc., 2) conduct on-farm trials, field days, farm visits and other in person events to demonstrate weed control practices, herbicide application and drift prevention techniques, 3) reduce row crop producer risks due to herbicide off-target movement, application error, crop injury, improper herbicide selection, and development of weed resistance, 4) convince producers to adopt ACES recommended practices to improve weed control efficacy, mitigate crop injury caused by herbicides, diversify herbicide resistance management with IPM strategies, and reduce herbicide drift complaints in the state of Alabama. Stakeholders served in this project include row crop farmers, pesticide applicators, crop consultant, chemical and seed dealers, ag industry/business, etc. **Outputs/Impact Statements (Results):** Weed control information and research updates were presented in-person in 3 field days, 2 webinars, 14 auxin trainings, 15 cotton and peanut production meetings, 1 crop consultant meeting. 2218 stakeholders received my weed control information in row crop meetings, auxin trainings and through virtual field days. Label requirements and best management practices to prevent dicamba drift were presented in 14 auxin trainings. Row crop growers received information well. ADAI only received two dicamba drift complaints in summer of 2020. Three stakeholders were organized to hear row crop growers' main pest problems and suggestion for future research. 50 Facebook posts were used to promote weed control research studies, sharing relevant information and news updates to growers. Those posts received 1047	Global Food Security and Hunger (#1)

		likes, 162 comments and 164 shares from stakeholders. I have over 500 row crop farmers as Facebook friend. 61 field studies were conducted throughout Alabama, plus 15 on-farm visits by myself during summer and fall of 2020. 5 peer reviewed journal publications, 19 professional conference presentations during 2021 from my program. A total of $328,250 funding and $24,900 unrestricted gift was received for my research and extension program in 2020 from 16 grant awards originated from USDA, commodity groups, industry contract research, AAES and ag chemical companies. In 2020 survey conducted in 20+ extension crop meetings and auxin trainings, 632 respondent farming 551,801 acres row crop reported my weed control information saved them $11.69 per acre. A total of 400 out of 632 respondents indicated they have used my weed control recommendations on their farms in the past (63.2%). These $ per acre savings growers reported has created $6,452,008 impact on AL row crop production in 2020. The total impact my Extension/Outreach program on AL row crop production since 2015 is estimated to be $16,364,399 (approved and published ACES impact). The return on investment of my Extension program is 30.1:1 since 2015, which indicates good investment from commodity checkoff funding, state, and federal government. Key Items of Evaluation(s) for NIFA Attention 1) Large number of stakeholders reached in multiple extension events 2) A variety of information outlets used during pandemic 3) The first in-person, drive-through field day was conducted for Alabama peanut and cotton producers during COVID, which has received acknowledgement from commodity group and local farmers 4) 100% integration of research and extension. All the research studies published in referred journal articles and presented in conference presentations have been used for extension programming and presented to row crop growers and other stakeholders. Only research and data-based recommendation is presented in extension programs. 5) Significant amount of economic impact from my extension programs	

		6) Low dicamba drift number every year since 2016. Only 2 cases of dicamba drift were reported in AL during 2020, which indicated my education effort to be effective.	
	AU Extension: Peach Program Report	**Brief Description:** Research and Extension efforts were centered on: 1) critical issues of lack of chilling 2) the soil-borne disease Armillaria root rot (ARR), and 3) other related issues (e.g., freeze damage/chill hours) that threaten the sustainability of the peach industry in Alabama. Research involved the evaluation of dormancy breaking chemistries that are applied when chilling accumulation is insufficient. These products have been found effective in alleviating dormancy, but more research is needed in determining optimal time of application and concentration of the chemistry being applied. In addition, research that investigates the effectiveness of a peach rootstock, 'MP-29' that is resistant to ARR and a planting strategy called root collar excavation (RCE) has been initiated. Currently, 'MP-29' is the only rootstock that has demonstrated resistance to ARR, but more research is needed in its adaptability to the Alabama soils. Furthermore, RCE has been shown to be effective in slowing the development of ARR in peach. The "Improving peach production and marketing in Alabama" Extension program in the Commercial Horticulture group of the Alabama Cooperative Extension Center was designed to be a conduit of practical application of knowledge gained from these studies. Chill hour monitoring & reporting service for growers & REAs: https://www.aces.edu/blog/topics/crop-production/chill-accumulation-monitoring-in-alabama/ **Outputs/Impact Statements (Results):** Number of participants: 600 Client groups: Established peach growers, beginning peach growers, military veterans and those in underserved communities, crop advisors, Regional Extension Agents, Extension Specialists, and other industry stakeholders. Percentage of growers in Chilton Co. planning to adopt measures: 87% Average Crop Value Increase: 82% Estimated ROI = 53:1 The bulk of the work was accomplished by on-farm visits/phone calls, webinars, workshops, meetings, and conferences. Research and Extension program	Global Food Security and Hunger (#1)

		received funding through state and federal agencies totaling approximately $100,000.	
	AU Extension: Nutrient Management Training	**Brief Description:** Livestock and poultry production in Alabama accounts for over $15 billion in income each year. Poultry alone represents 65.6% of annual farming revenue in the state and employs around 86,000 people. Alabama has roughly 3,000 family farms engaged in poultry production. Over 1.5 million tons of poultry litter are generated on these farms annually. The organic matter and nutrients in litter are important for crop production, hay fields and grazing lands. Managing this valuable nutrient source correctly is vital to sustaining crop production while protecting water quality on farms and ranches across the state. State and federal regulations govern animal manure management. Alabama Extension leads the educational effort across the state for this topic. Extension facilitates the Inter Agency Waste Team, along with NRCS, that collaborates on every facet of manure management. Approximately 1,000 farms in Alabama are permitted, animal-feeding operations that require 6 continuing education units each year. In lieu of those units, growers can pay a $500 Greenfield fee, thus making each hour of training worth $83. **Outputs/Impact Statements (Results):** 10 peer-reviewed publications were written and revised in 2020. 3 technical presentations 1228 social media information sharing and interactions. 169 hours of continuing education earned by growers. $14,027 value of the continuing education COVID-19 pandemic cancelled all grower meetings.	Global Food Security and Hunger (#1)
	AU Extension: Grow More, Give More (SOW a Garden)	**Brief Description:** The Extension Home Grounds team has a popular smart device app, "SOW a Planting Companion". At the beginning of 2020, our Program name for home food gardens was "SOW a Garden". When the pandemic became evident, a new program was developed, "Grow More, Give More." The goal of both is to teach best management practices for a productive residential food garden. Our new program adds a philanthropic component that has both energized our volunteer network (Extension Master Gardeners) and various communities around the state. This is a multi-team, multi-level effort in creating and delivering content.	Global Food Security and Hunger (#1)

		Issue: Creating and sustaining a productive residential or community garden can be hindered by factors such as lack of technical knowledge, lack of resources, lack of volunteer involvement and other local support. Objectives: 1) Provide research-based instruction to help clientele successfully start/restart and maintain a residential food garden. This issue became even more important during the pandemic of 2020. This health crisis necessitated the creation and delivery of digital resources that could be accessed at the client's convenience and still inserted into Agents' programs. These resources are housed on the ACES Grow More Give More webpage. 2) Address increasing food insecurity through the addition of a philanthropic (produce donations) component to our gardening program. **Outputs/Impact Statements (Results):** Training programs offered – 76 (34 face to face; 42 virtual); Program participants/attendees – 4,582; Demonstration gardens participating – 16; Number of GMGM-ACES webpage visits – 4,344; Number of SOW App downloads – 10,647; Number of GMGM video views – 2,960. 72% of participants in Grow More, Give More public programs reported that they implemented something from our program (n=649). More than 18 tons (36,753 lbs.) of fresh produce were donated across Alabama. We recruited volunteers as Grow More, Give More Ambassadors in every county (in ~80% of our state). This tremendous teamwork effort rewarded many communities with new sources of fresh produce. 5,861 families received fresh produce from local food charities that was donated through the Grow More, Give More project. The retail value of all reported Grow More, Give More donated produce was conservatively estimated = $66,155 (average price, $1.80/pound). From program surveys, participants reported an average value of $80/program. Based on the number of views to our GMGM tutorial videos (n=2,960), this equals a 28:1 return on investment for Grow More, Give More.	

	AU Extension: Alabama Crop Management	**Brief Description:** The Alabama Crop Management program is a multi-faceted approach of the Agronomic Crops team to aid Alabama farmers in making informed decisions within their respective operations. The main components of this program are on-farm variety testing and selection. Information is generated through statewide on-farm variety testing for agronomic row crops with valued stakeholders. Testing of varieties in farmer's fields educates them on what varieties perform consistently and are most profitable on their acres. Information generated from these trials is disseminated via individual contacts, extension publications, newsletters, websites, and social media pages. Sub-components of this program include but are not limited to fertility, weed management, insect management, and in-season cropping issues. **Outputs/Impact Statements (Results):** In a recent survey of over 600 Alabama growers, were asked to provide a list of their top 10 most important issues. Variety trials and variety selection was one of the top 3 answers provided. In particular, variety trials performed on their respective farms. A total of 16 on-farm cotton variety trials were planted across the state representing major production areas and niche environments throughout the state. The USDA Cotton Varieties planted report indicated that nearly half of all Alabama Cotton acres planted were comprised of the top yielding variety from our on-farm variety trials. Trial data from the previous growing season indicated that if a grower planted the top yielding variety, there would be a gross return of $826/acre. If the median yielding variety were planted, there would be a gross return of $803/acre. If the lowest yielding variety were planted, a net return of $690/acre would be represented. This indicates the potential for either a loss or gain of $136 per acre from choosing the worst or best variety. A net loss or gain of $136 per acre across several thousand acres will have a tremendous positive or negative impact with respect to ROI.	Global Food Security and Hunger (#1)

		Corn, Wheat, and Soybean variety trials were also planted statewide, helping to accomplish the same results.	
	AU Extension: Sustainable Crops Educational Programs	**Brief Description:** 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 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. The goal of this project was to diagnose plant health problems in Alabama through onsite visits, phone/email communication, and laboratory diagnostics. Immediate responses to critical issues and assessment of causal agents provide IPM options growers can utilize to solve current problems in a timely manner and prevent future problems. Critical issues include weather abnormalities; insect infestations; disease introduction and spread; and unsound cultural, chemical, and fertilization practices. Presentations on disease trends are also provided to growers at production meetings and conferences. In addition to one-on-one education with growers and meetings, pest alerts and other educational information are disseminated when concerning trends are observed in pest populations or new diseases/insects are identified through electronic communications, newsletters, fact sheets, workshops, webinars, and peer reviewed publications. Throughout the year 1% of clientele are surveyed to determine specific impacts based on recommendations provided through diagnostics. **Outputs/Impact Statements (Results):** The Auburn University Plant Diagnostic Lab processed 1809 samples during 2020. This was a record high for the lab. Each sample processed allows for one-on-one grower education of their specific problem and individualized IPM recommendations. Of the 1% clientele surveyed throughout the year to determine specific impacts based on recommendations provided through diagnostics, the diagnostic lab saved an average of $589/sample from following our recommendations. With 1809 samples processed this year, the diagnostic lab potentially saved $1,065,501 in direct benefits. Additionally, of the clients surveyed, 100% indicated they adopted/plan to adopt the IPM recommendations provided by the diagnostic lab.	Global Food Security and Hunger (#1)

		From these samples, nine pest alerts were disseminated through electronic communications, IPM Communicator newsletter issues, fact sheets, workshops, webinars, and peer reviewed publications; five first reports were identified; and one regulated pest was identified and reported to regulatory authorities.	
	AU Research: Climate effects on row crops	**Brief Description:** How does climate variability affect crop yields and what is farmers' adaption potential in the Southeastern US. A project titled "Maladaptation of U.S. Corn and Soybean Yields to a Changing Climate" was conducted. The work uncovered the inherent trade-offs and limitations of existing approaches to crop adaptation. Results show that although the two crops became more heat- and drought-tolerant, their productivity under normal temperature and precipitation conditions decreased. **Outputs/Impact Statements (Results):** From 1951-2017, heat- and drought-tolerance increased corn and soybean yields by 33% and 20%, whereas maladaptation to normal conditions reduced yields by 41% and 87%, respectively, with large spatial variations in effects. Row crop producers, Crop consultants, federal and state soil & water conservation agencies	Global Food Security and Hunger (#1)
	AU Research: Economics of Aquaculture Production in Alabama	**Brief Description:** Enterprise budgets are needed to integrate tilapia production effluent into greenhouse vegetable production to create viable operations. Tilapia production effluent was integrated into greenhouse vegetable production. Research focused on life cycle analysis of the system by measuring all inputs and outputs, biological, chemical and price/costs to develop enterprise budgets of the system. **Outputs/Impact Statements (Results):** The tilapia greenhouse produced 6,619 pounds and produced 12,222 pounds of cucumbers from October 2018 to September 2019. Cost of production for tilapia and cucumber covering all costs was $3.08/lb. and $1.98/lb. respectively and compared to the selling prices of $2.50 (tilapia) and $1.20 (cucumber), the loss per pound of each product was $-0.58 and $-0.78 respectively. When a sensitivity analysis of adding an additional plant, greenhouse was added the operation became profitable with a net return of $8,975. This indicates there is an economies of scale as the fish effluent has been calculated to be sufficient to supply the majority of plant nutrients and suppling them to only one plant greenhouse was inefficient. When three and four plant greenhouses (and one fish	Global Food Security and Hunger (#1)

		greenhouse) were run, the net returns were $14,471 and $23,727, respectively. Aquaculture producers, extension services, researchers, students, policymakers, and general public.	
	AU Research: Forage-based beef production systems for Alabama	**Brief Description:** As alfalfa utilization expands into the Southeastern U.S., there is growing interest in incorporating this high-quality legume into hybrid bermudagrass. A 2-yr small-plot trial was conducted to evaluate the effects of harvest height and frequency on herbage accumulation, botanical composition, and nutritive value of a newly established 'Bulldog 805' alfalfa inter-seeded into an existing 'Tifon-85' bermudagrass stand (ABG). From this, preliminary management recommendations can be defined for the Southeastern U.S. and define parameters for next-step evaluations under grazing. In 2018, thirty-six alfalfa-bermudagrass plots were established at 2 locations across southern Alabama and Georgia, in a 3 × 3 factorial design with four replications at each location. Treatments included combinations of harvest height (5, 10, 15 cm) and harvest frequency (2, 4, or 6 weeks). **Outputs/Impact Statements (Results):** Harvest frequency, height, and their interaction affected ABG botanical composition and nutritive value, with decreasing alfalfa contribution and quality characteristics with increasing length between harvest dates. More intensive defoliation height regimes (i.e., 5 cm) decreased alfalfa contribution over the growing season. Mixtures harvested at 10 cm every 4 weeks optimized stand herbage accumulation, nutritive value, and alfalfa persistence across the two seasons at both locations. Results from this study helped identify preliminary defoliation management recommendations for ABG mixtures for the Southeastern U.S. and can be used to define parameters for next-step evaluations under grazing. Target Audience: Research scientists, extension professionals, beef cattle farmers, agribusiness, and the public.	Global Food Security and Hunger (#1)
	AU Research: Soil Health Research in Alabama Row Crop Systems	**Brief Description:** Research is needed to determine the best methods for assessing short-term improvements in soil health in highly weathered Ultisols of the Southeast. Evaluated dynamic soil health indicators affected by 1) cover crops in cotton-	Global Food Security and Hunger (#1)

		legume cash crop rotations; and 2) incorporation of winter grazing livestock into a cotton-peanut rotation with a winter cover crop mixture. **Outputs/Impact Statements (Results):** Some improvements in soil health indicators were observed following two years of field experiments, but more time is needed to thoroughly evaluation the impact on soil health. Target Audience: Row crop producers, Crop consultants, federal and state soil & water conservation agencies	
	AU Research: Mechanisms for Herbicide Resistant Weeds	**Brief Description:** The development of herbicide resistant weeds is an increasing problem in agricultural systems. Genetically modified crops, despite their tremendous value, exacerbate the problem because they foster the use of a single herbicide mode of action. Evaluated herbicide resistance in goosegrass populations collected from Alabama, South Carolina, and Florida. Investigated ACCase inhibiting herbicide resistance mechanisms and developed molecular tools for monitoring resistance development in weeds. **Outputs/Impact Statements (Results):** Demonstrated the utility of the malachite green-phosphate assay as a functional ACCase resistance detection assay. Oxadiazon resistant goosegrass populations were sequenced and confirmed the importance of the Ala-212-Thr amino acid substitution as the principle means by which goosegrass has evolved resistance to oxadiazon. Target Audience: Scientists, professional turfgrass managers, crop producers, and general public.	Global Food Security and Hunger (#1)
	AU Research: Management of insect-vectored pathogens in row crops	**Brief Description:** Cotton blue disease, caused by the cotton aphid transmitted cotton leaf roll dwarf virus (CLRDV), is an emerging disease that poses a significant threat to the profitability of the U.S. cotton industry. CLRDV has been detected in 21 Alabama counties along with multiple counties in Florida, Georgia, and Mississippi. Research trials were conducted to investigate transmission of CLRDV and the impact of aphid management on reducing final incidence of CLRDV.	Global Food Security and Hunger (#1)

		Outputs/Impact Statements (Results): Research has confirmed that the cotton aphid and no other aphid species or the sweet potato whitefly is the vector of CLRDV. Cotton aphid is resistant to the commonly used insecticides used in their control. For example, imidacloprid resistance in Alabama ranged from 4–278 fold, 95% of populations had greater than 10-fold resistance, and 50% of the populations had greater than 100-fold resistance. Field trials have shown that CLRDV cannot be managed by spraying insecticides alone and that IPM systems may be the only successful approach to managing this aphid-vectored virus. Target Audience: Scientists, extension personnel, crop consultants and producers, and public.	
	AU Research: Insecticide resistance in public health pests	**Brief Description:** The house fly is an important mechanical vector of a number of diseases by contaminating food and surfaces. These pests are controlled using insecticides and significant resistance has developed to most insecticides. Identification of resistance mechanisms and genes will provide critical information for managing these pests. A functional analysis of house fly carboxylesterase genes and their expression were explored in laboratory studies. **Outputs/Impact Statements (Results):** Multiple carboxylesterase genes were identified, and expression levels were significantly upregulated in pyrethroid resistant house flies. These carboxylesterases efficiently and specifically hydrolyze α-naphthyl acetate rather than β-naphthyl acetate. A cytotoxicity study indicated that carboxylesterase-expressing cells had enhanced tolerance to permethrin confirming the importance of carboxylesterases as a resistance mechanism. Carboxylesterase-resistance is relatively poorly known and less well-studied compared with other mechanisms (e.g., CYP450). Target Audience: Scientists, extension personnel, public health consultants, food production and storage professionals, and the general public.	Global Food Security and Hunger (#1)
	AU Research: Plant pathogen molecular ecology on vegetables	**Brief Description:** Plant pathogenic bacteria have multiple strategies to colonize and infect plant hosts. Emergence of new strains pose problems for disease management and resistance breeding programs. It is unclear why new strains of pathogens emerge	Global Food Security and Hunger (#1)

		and how they can be prevented or mitigated. The bacterial spot disease of tomato and pepper caused by Xanthomonas spp. is a model system for studying pathogen biology. Samples from 12 fields were collected and pathogen diversity was determined at the intra-subspecific level using a shotgun metagenomics approach. **Outputs/Impact Statements (Results):** Multiple pathogen genotypes of Xanthomonas spp. can coexist in the same fields. Several different species of pathogens including Pseudomonas cichorii can also coexist in the same field and even on the same plant. This metagenomics approach provides a snapshot of the pathobiome in tomato and pepper fields. Target Audience: Scientists, extension personnel, biotech industry, agriculture producers and allied industries, and the general public.	
	Tuskegee Extension: Beef Cattle Herd Health Management Demonstrations	**Brief Description:** 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. **Outputs/Impact Statements (Results):** 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.	Global Food Security and Hunger (#1)

		As a result, 8 livestock producers established or renovated approximately 90 acres of forages. Three beef producers purchased performance tested bulls to improve herd genetics and market calf's quality. In addition, performance tested bulls were able to help beef producers to improve calf crop percentages, weaning and market weights. Calf crop %'s improved on average from 82% to 91 % and weaning weights improved by 160 lbs. and markets only improved by 30lbs on average.	
	Tuskegee Research: Organic chromium supplementation	**Brief Description:** Small cow-calf producers receive lower market price due to year-round marketing of small number and less efficient calves. Preconditioning is the management practice of minimizing stresses and subsequent risk of illness and consequently improve immunity and health of the animals for maximum animal performance and profits before they reach the feedlot. The objective of this study was to highlight the advantages of preconditioning marketing system and to assess the effect that organic chromium supplementation has on animal performance. Angus cross beef calves (n = 120) were randomly assigned to pens (n = 12 pens; 6 pens/treatment; 10 calves/pen) in a completely randomized design. Animals were fed 50/50 soyhulls and corn gluten feed top-dressed with 0.4% KemTRACE® Chromium. Body weights were measured, and results were analyzed. **Outputs/Impact Statements (Results):** The result showed that total weight gain and average daily gain of beef calves fed with Chromium were higher than that of control groups but were not significantly different (P > 0.05). On the other hand, feed efficiency was lower for chromium fed animals compared to the control groups but not significantly different (P > 0.05). The average sales price was higher for board sales by $0.05 per lb. than that of traditional sales in the state of Alabama during March 2020. These results suggest that preconditioning practices may help to improve the animal performances and economic gain. Preconditioning practices can be profitable management practices if small and limited-resource producers work in groups (clusters).	Global Food Security and Hunger (#1)
	Tuskegee Research: Diurnal behavior and distribution patterns	**Brief Description:** Woodlands offer a great potential for expanding the grazing opportunity for small ruminants. Study objectives were to determine the diurnal behavior and distribution pattern of Kiko wethers and Katahdin rams in woodlands with	Global Food Security and Hunger (#1)

		different vegetation heights during 1) summer, 2) fall, to determine the 3) potential of increasing a) light influx to woodland floor and b) understory biomass production by altering the height of non-target plants, and 4) to a) determine the utilization pattern of woodland vegetation present at different heights by small ruminants and b) evaluate the performance of small ruminants while stocked in woodlands. Studies were conducted in six woodland plots (1-acre each) containing southern pine (longleaf (Pinus palustris Mill) and loblolly pine (Pinus taeda L.)), hardwood trees, and numerous understory vegetation. The non-target (non-pine) plants were either cut at 0 feet, 3 feet, or 5 feet from the ground level or left uncut (control). **Outputs/Impact Statements (Results):** Vegetation heights, openness, and diurnal period influenced the behavior and distribution of animals. Cutting non-target plants to low heights (0'-5') increased solar radiation influx to the ground, understory vegetation biomass, and influenced the selection of plants by animals. Research results showed that maintaining non-target plants within the reach of animals (goats: ≤ 5.2 feet; sheep: ≤ 3.7 feet) would increase the availability and utilization of understory vegetation, resulting in a desirable performance of small ruminants.	
	AAMU Research: An Integrated Study on Solanum Alkaloids in Selected Novelty Potato Cultivars	**Brief Description:** Solanum alkaloids are found in many species of plants, but are abundant in Solanaceae family, which include the potato. Because of their natural presence in the potato, many questions have been raised about the safety of the potato for consumption. Supercritical Fluid Extraction (SFE) method will be developed to extract Solanum alkaloids in selected novelty potato cultivars. Although Solanum alkaloids are known to be toxic to humans, interestingly, these same alkaloids may also have beneficial effects in human health. This study will aim to provide answers through integrated approaches to elucidate the molecular mechanisms of action of the safety and potential toxicity of Solanum alkaloids. What has been done? (1) Screened different extracting solvents to determine optimum solvent system for extracting total glycoalkaloids (TAG) and polyphenol contents in five novelty potato varieties. (2) HPLC analysis to quantify Solanum Alkaloids, Anthocyanins and Phenolics compounds in selected novelty potato varieties. (3) Determined the toxicity and therapeutic effects of novelty potato extract and TAG in the Caenorhabditis elegans model	Food Systems and Food Safety (#2)

		Outputs/Impact Statements (Results): Identified the optimum solvent for TAG and polyphenol extraction in novelty potatoes. Identified novelty potato with the highest TAG and polyphenol contents (Food and Nutrition Sciences Vol.11 No.10). (2) Novelty potato extract prevented was non-toxic to Caenorhabditis elegans TAG was toxic to Caenorhabditis elegans and induced oxidative stress. Results are being compiled for graduate MS report. Target Audience: Scientists, students, potato growers, food industry and general public	
	AAMU Research: Identification of Small RNA'S as Novel Regulatory switches in the Envelope Stress Response in Escherichai coli	**Brief Description:** It is reported that 39% of food-borne illness is caused by bacteria, making bacterial infections a major public health threat. Pathogens such as Escherichia coli (E. coli) that contaminate our foods and cause food-borne illness utilize various pathways that facilitate their ability to adapt to stress and survive in dynamic environments. Food safety efforts are dependent on an understanding of these pathways well enough to prevent them (Behravesh, Casey B). E. coli O157:H7 has been identified as one of the top five pathogens that cause food-borne illnesses that result in hospitalization. This emerging food-borne pathogen is the most common cause of outbreaks of E. coli infection, making it a public health priority. (Gould, L. Hannah). E. coli O157:H7 releases one of the most potent toxins known to man, the Shiga-like toxin. These toxins are very dangerous as they have a really small infectious dose (ref). The resulting infection can lead to severe, life-threatening complications and even death (ref). E. coli O157 is constantly evolving, mutating, and acquiring new characteristics that creates new challenges in food safety and public health. This ability to exploit different mechanisms of survival necessitates additional research to further understand its pathogenicity. Current data provides an alarming depiction of how antibiotic resistance in E. coli has increased over time. Studies show that small regulatory RNA molecules influence bacterial antibiotic resistance. E. coli is one of the most extensively studied pathogens and although great progress has been made to reduce the burden of food-borne illness overall, little progress has been made to reduce the incidence of E. coli O157 infections (ref). If we are to make food safer, we must focus on reducing levels of microbial contamination. **Outputs/Impact Statements (Results):**	Food Systems and Food Safety (#2)

		The major objective of this project is to determine if the small RNA RyhB directly regulates RseA translation. This was by identifying nucleotide point mutations in the RyhB small RNA that affect its regulatory activity on PBAD-rseA27-lacZ. Next, an identification of compensatory nucleotide point mutations in the RseA 5'UTR portion of PBAD-rseA27-lacZ translational fusion that restore the regulatory ability of RyhB point mutant. The project has elucidated the possible direct role of RyhB in bacteria post-transcriptional regulation of the envelope stress response. Via complementation assays we have identified key nucleotides in the RyhB small RNA are necessary for direct interaction with the messenger RNA in order to have a stimulatory effect on translation, suggesting direct interaction. This project has provided an opportunity for undergraduate research experience at Alabama A&M University. The undergraduate student working on this project got hands on experience with basic Molecular Biology and Microbiological techniques including aseptic technique, making biological media, isolating, and culturing bacteria, conducting polymerase chain reactions, etc. These skills will be of great use for the research trainee as she continues undergraduate research experiences. In February 2021, a manuscript of the research findings entitled “Post-transcritional Regulation of RseA by small RNAs RyhB and Fnrs in E. coli” was submitted for publication in the journal Frontiers in Molecular Biosciences, section on Protein and RNA Networks.	
	AU Extension: Beef Cattle Performance Programs to Enhance Profitability (BCIA)	**Brief Description:** The overall objective is to increase the knowledge and skills of commercial and seedstock beef cattle producers to make sound genetic selection decisions to enhance herd profitability and marketing in beef cattle. Specific outcomes are to increase beef farmer and rancher knowledge in sustainable livestock production with the implementation of beef performance records, utilizing genetic selection tools and appropriate marketing options and to improve economic conditions in the adoption of sustainable practices and improve animal husbandry management. The target audience is commercial and seedstock beef cattle producers and beef cattle industry organizations and professionals. **Outputs/Impact Statements (Results):**	Food Systems and Food Safety (#2)

		Total herds enrolled and processed data in the Alabama BCIA Commercial Record Keeping Program equaled 48 herds, 3,609 total calves, and average adjusted weaning weight of 569 lbs. 5 new herds were added, and 4 herds expanded herd inventory. Alabama BCIA Performance Advocate Program implemented to recognize herd efficiency and to encourage more total herd performance record keeping. 5 operations were recognized to be meeting all or a significant level of these data areas. 154 beef cattle operations impacted by breeding animal marketing opportunities and superior genetic selection for an economic impact of $797,450 from 389 animals marketed from 45 participants to 109 buyers. Replacement heifers bred from 7 to 9 months marketed reflected an average revenue increase per head of $998.65. Replacement heifers bred from 4 to 6 months reflected an average revenue increase per head of $807.93. Open replacement heifers marketed reflected an average revenue increase per head of $230.00.	
	AU Extension: Opportunities for Value-Added Livestock Marketing	**Brief Description:** The overall objective is to increase farmer and rancher knowledge and expertise in various value-added marketing options. Education and guidance in value-added marketing opportunities, such as co-mingled feeder calf programs, retained ownership, seedstock bull sales, and replacement heifer sales. Guidance in adding value and options to market feeder calves in economic units and breeding animals with emphasis on genetic data. Specific outcomes are to increase knowledge and participation in value-added marketing programs, to improve economic conditions and to increase revenue of farmers and ranchers. The target audience is commercial and seedstock beef cattle producers and beef cattle industry organizations and professionals. **Outputs/Impact Statements (Results):** Total economic impact of value-added livestock marketing opportunities equaled to $7,340,172.35 in 2020. Economic impact of 2 highlighted value-added feeder calf marketing events represented 5,842 of Alabama bred and raised feeder calves from 41 beef operations worth $5,844,366.89. On average an increase in price per hundred	Food Systems and Food Safety (#2)

		pounds of $18.40 for steers and $18.88 for feeder heifers resulted in $166.95 per steer and $140.11 per heifer in increased revenue. For breeding animal marketing events, an economic impact of $797,450.00 from 389 head marketed from 45 participants to 109 buyers was reached. Retained ownership marketing opportunities represented 703 Alabama feeder calves from 44 beef operations worth $698,355.46 at the time of harvest. Participants in the 2019-2020 Alabama Pasture to Rail Program were able to capture an additional profit of $112.10 per head beyond the value of the feeder calves at the time of shipment from Alabama. Return on investment of $18.76 to $1.00 resulted for the 2019-20 Alabama Pasture to Rail Program.	
	AU Research: Management of herbicide resistant weeds	**Brief Description:** Palmer amaranth is an economically damaging agronomic weed found throughout the southern United States. In 2016 it was listed as the number one most problematic weed found in broadleaf row crops in the U.S. The overreliance by row crop producers on several types of herbicides has led to widespread resistance to them by this weed. Palmer amaranth can cause up to 28% peanut yield loss, due to its rapid growth, high water use efficiency and drought tolerance. Due to prevalence of ALS resistant Palmer populations in the southeast, producers have to rely on PPO inhibitor herbicides for Palmer control in peanut production. Reliance on this class of herbicide means that there is a risk of developing resistance to PPO. If this were to occur, peanut producers would be severely limited in their herbicide options to control this weed. In 2019, Alabama was the third largest producer of peanuts in the US with row crop producers planting 155,000 acres of peanuts in 37 counties, thus the future risk of PPO resistant Palmer is substantial. With peanut producers already constrained by limited herbicide options due to it being a non-GMO crop, evaluating alternative, non-chemical methods for weed control is imperative for the future of peanut production. To evaluate the efficacy of various integrated weed management programs that include a combination of cover crop biomass, tillage practices, mechanical control, agronomic practices, herbicide programs and weed wipers on PPO and ALS resistant Palmer amaranth in peanut crops. **Outputs/Impact Statements (Results):** Field research studies were conducted at two locations in Alabama in 2020 to evaluate if we can control Palmer amaranth without relying on PPO and ALS herbicides. Results were very encouraging. We were able to reduce Palmer	Food Systems and Food Safety (#2)

		amaranth number and biomass by 99% compared to control without using PPO herbicides or abusing paraquat which is highly toxic to mammals and very injurious to peanut plants. This is the first report in the US regarding successful control of ALS and PPO resistant Palmer amaranth. Target Audience: Row crop farmers, crop consultants, chemical and seed dealers, extension personnel, government agency employees.	
	AU Research: Food marketing in Alabama and the Southeast	**Brief Description:** 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 the unique diets in the Southeast. 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. This project will benefit consumers in Alabama and the Southeast who are at higher risk for illnesses associated with obesity such as diabetes. In addition, this project will benefit Alabama producers and agribusiness by highlighting potential strategies to market foods to consumers in the Southeast. An online survey of 2,000 Alabama consumers and retailers investigating organic food preferences and marketing was conducted. **Outputs/Impact Statements (Results):** Alabama has few organic producers and lower demand for organic products than many other states. This survey has shed light on Alabama's producer's ability to market locally grown organic products. Target Audience: Food consumers, farmers, organic farmers, organic retailers, southeast food bank and food pantry administrators, government officials.	Food Systems and Food Safety (#2)
	AU Research: Improving Economic Sustainability and Resilience of the Off-Bottom Oyster Farming Industry in the northern Gulf of Mexico	**Brief Description:** Routine handling of oysters is a common industry practice for off-bottom oyster aquaculture, which aims to produce a high-quality oyster. These practices expose oysters to elevated temperatures and interrupt filter feeding, which can increase the foodborne pathogen levels of Vibrio vulnificus and V. parahaemolyticus within the oyster. The re-submersion of oysters after exposure to conditions where the time-temperature controls are exceeded is as an effective mitigation	Food Systems and Food Safety (#2)

		strategy to allow elevated levels of Vibrio spp. to "recover", or return to ambient levels, prior to harvest. Previous work examined the effect of desiccation on recovery times. The objective of this study was to evaluate the effect of additional handling treatments [tumbled and refrigerated (TR), tumbled and not refrigerated (TNR), not tumbled and refrigerated (NTR), and not tumbled and not refrigerated (NTNR)] on the time needed for V. vulnificus, total V. parahaemolyticus, and pathogenic V. parahaemolyticus (tdh+/trh+) to recover in oysters. A set of non-treated (control) oysters remained submerged throughout the study to determine the ambient Vibrio spp (inclusive of genotypes) levels within oysters. Vibrio spp. levels were measured immediately before (pre) and after (post) the treatments, and 1, 2, 4, 7, 10, and 14 days after re-submersion using a three-tube MPN real-time PCR method. **Outputs/Impact Statements (Results):** The non-refrigerated oysters (TNR, NTNR) had Vibrio spp. levels of 1.54 to 2.10 log MPN/g higher than the pre-treatment levels, while the Vibrio spp. levels in refrigerated oysters were not significantly higher than pre-treatment levels. After re-submersion, Vibrio spp. levels increased by 0.84 to 1.78 log MPN/g in the refrigerated oysters (TR, NTR). Vibrio spp. levels in oysters returned to ambient after 1-7 days of re-submersion, depending on the handling treatment and the Vibrio spp looked at. These results provide data on handling treatments not previously reported and further support the seven-day re-submersion requirement for oyster farmers using the adjustable longline system. Target Audience: Commercial oyster farmers, potential commercial oyster farmers, regulators (state, federal), legislators, and interested members of the general public.	
	AU Research: Enhancing Poultry Production Systems through Emerging Technologies and Husbandry Practices	**Brief Description:** Animal feed is a known potential source of pathogens that can infect food animals destined for human consumption. These pathogens include those that may directly infect the animal, such as C. perfringens or ones that may get people sick (Salmonella) if it makes it into the final product sold to the consumer. Testing in these facilities for bacterial pathogens is sporadic and the ingredient sources used in creating the feed are rarely tested for pathogen presence.	Food Systems and Food Safety (#2)

		Samples were collected from various location within five feed mills throughout Alabama during the summer and winter months. These samples were tested primarily for Clostridium, E. coli and Salmonella spp; however total spore former levels were also taken and if needed identified. **Outputs/Impact Statements (Results):** The results from these feed mills had no recovery of Salmonella in any sample taken; however, E. coli recovery was possible if the feed mill and finished feed was either poorly managed (improper feed temp or mixing) or the feed improperly handled ("clean' feed put in contaminated bins). In addition, several spore forming Clostridia and Bacillus survived the pelleting process. These bacteria were further identified as Clostridium argentinense and Bacillus proteolyticus and are in the process of being further characterized. Since they potentially can be pathogenic to animals or people. Through this research it was discovered that these bacteria either originated from the feed ingredients or had persisted in the feed mill from previous feed batches. These findings show the importance of proper feed mill cleaning in preventing the spread of potentially pathogenic bacteria. It also shows that Salmonella is typically not found in finished feed or the ingredients. Target Audience: Poultry farmers, poultry company representatives, researchers, government regulators and consumers.	
	AU Research: Comparative and functional genomics, epigenomics and metagenomics in food animal health	**Brief Description:** Lactocrine insufficiency from birth in pigs, indicated by reduced serum immunoglobulin immunocrit (iCrit) ratios in nursing piglets on the day of birth (postnatal day 0, PND0), can alter the postnatal uterine developmental program and reduce lifetime fecundity. To determine the effects of lactocrine insufficiency from birth on the gut microbiome and uterine transcriptome, we performed transcriptomic sequencing of uterus samples in PND14 gilts collected at the US Meat Animal Research Center (Clay Center, NE). **Outputs/Impact Statements (Results):** 148 genes were identified to be differentially expressed between individuals that received sufficient colostrum (high-iCrit group) and suboptimal amount (low-iCrit group), at a P-value cut-off of 0.05. The gut microbiome analysis generated 713 billion bp of microbial sequences from six high-iCrit and six low iCrit fecal	Food Systems and Food Safety (#2)

		samples. The most abundant phyla are Firmicutes and Bacteroidetes, which is consistent with adult swine microbiome profiles reported in the literature. It was discovered that an enrichment of Bacteroidetes (P=0.002, paired Mann-Whitney U test) and a significant reduction of Actinobacteria (P=0.03, paired Mann-Whitney U test) in high-iCrit as compared to low-iCrit samples. These results revealed the potential genetic and metagenomic mechanism of Lactocrine insufficiency. Target Audience: Scientists, students, policymakers, and livestock/poultry industry personal.	
	AU Research: Molecular Mechanisms Regulating Skeletal Muscle Growth and Differentiation	**Brief Description:** Wooden breast is a serious economic issue with commercial poultry production. It is not a direct health issue for the animal or for the consumer but is a defect in the breast muscle that most consumer find unsavory. The exact cause of this muscle myopathy is unclear. The role of lighting and dietary amino acid density on bird growth, satellite cell activity, and the incidence of Wooden Breast was performed. **Outputs/Impact Statements (Results):** In this study, reductions in light intensity and dietary metabolizable energy and digestible lysine density during the starter period did not result in a reduction in breast meat yield, changes in satellite cell activity, or incidence and severity of Wooden Breast. A 15% dietary nutrient reduction was not severe enough to impact broiler body weight or rate of gain as birds compensated for the reduction in nutrients by increasing their feed intake. Overall, these results contribute to the knowledge regarding the role that myogenic stem cells (satellite cells) may play a role in the development of Wooden Breast. This information adds to the body of knowledge surrounding the Wooden Breast condition and will aid the poultry industry in furthering the investigation into the cause and strategies to eliminate this meat quality defect from the poultry meat supply. Target Audience: Scientists, animal industry personnel, feed ingredient suppliers, animal health professionals, extension personal, governmental policy makers, students.	Food Systems and Food Safety (#2)

	Tuskegee Extension: Sustainably Produced Food	**Brief Description:** 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. **Outputs/Impact Statements (Results):** The #Earth2TU launched with the first virtual conference/symposium with EarthWeek 2020, which was a series of 5 symposia dealing with the complete value chain of hemp/cannabis. Over 109 participants joined the discussions from all over the country. The virtual platform continued for another 6 sessions and adding another 134 participants. Topics included the Alabama Hemp Industry, the history of Lowndes County and production agriculture and its connection to Civil Rights History, African American Churches and Food Security, African Americans in the Cannabis Industry, and Land Access. Fact Sheets, Bulletins, and digital media were additional communication outputs from the program. Over 90% of participants reported a gain in (in each of the areas presented) knowledge with respect practices related to industrial hemp, cannabis, and racial equity in food systems, including other areas in agriculture. Ninety one percent (91%) participants said that they will utilize knowledge and skills gained and change their behavior to improve operations and interactions in their local food system.	Food Systems and Food Safety (#2)
	AAMU Extension: Home Grounds, Gardens and Home Pests	**Brief Description:** Back 2 Basics virtual workshops and seminars were held to educate a statewide audience 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. **Outputs/Impact Statements (Results):**	Natural Resource and Environmental Sustainability (#3)

		There were 35 Back to Basics sessions held in 2020, with 6,689 registrants and 1,230 live participants. Thirty of the sessions were recorded for later viewing on the Extension website. Recorded data from the Extension webpages for the sessions indicated 465 Views & Downloads and 3,000 minutes delivered. Also, recorded data from Facebook indicates that the sessions were reached by 27,613 persons and included 4,507 views with 1,551 further engagements and 218 shares. Responses to post-session evaluations indicated that 95% of participants indicated that they would save money by adopting practices covered in the workshops ($0-50@64%, $50-100@21%, $100-150@5%, and $200 or more @ 10%).	
	AAMU Extension: Forestry, Wildlife and Natural Resources	**Brief Description:** In 2020, a city-wide e-waste recycling drive was held in partnership with the Better Business Bureau (BBB) and several other local agencies. **Outputs/Impact Statements (Results):** A total of 112 cars dropped off 3,000 pounds or 1.5 tons of e-waste at a Decatur, AL event, representing a 150 percent (150%) increase from last year's event. As a result of this drive, 10,765 lbs. (4882.90 kgs) of carbon emissions were deferred from entering the atmosphere, according to the e-waste calculators. This equates to 415 trees being saved as well as the production of 15,625 plastic bottles and 1,831 gallons of gasoline [@ $2.60 per gal. = $4,761.00]. These activities also resulted in the reclamation of plastic, nylon, steel, copper, aluminum, and other resources. The economic gains observed from the 3,000 lbs. of e-waste recycled via the city-wide drive are estimated at $240.00 (i.e., pounds of wire @ $0.8/pound). Application of additional EPA conversion factors revealed that the 3,000 lbs. of e-waste could save 6,211,920 hours of electricity in the upcoming year.	Natural Resource and Environmental Sustainability (#3)
	AAMU Research: The Effect of Various Nitrogen Rates on Plant Biomass and Elemental Content of Holy Basil Harvested at Different Maturity Dates	**Brief Description:** Holy basil (Ocimum tenuiflorum) is widespread both as a native and cultivated plant throughout the Eastern tropics, where it is cultivated for religious, medicinal, and food purposes. Because of its popularity and many uses, Holy Basil has become a subject of intense studies to understand the morphological characteristics, chemical composition, as well as vegetative growth potential of the plant in temperate environments. Intelligence). Part of this belief is that the smell of the plant is effective in keeping away insects that Alabama has the atmospheric environmental conditions that are not too different from those that	Natural Resource and Environmental Sustainability (#3)

		the plant flourishes. However, Alabama soil conditions are likely different from those that the plant flourishes, partly because the different major soil areas of the state (Limestone Valleys and Uplands, Appalachian Plateau, Piedmont Plateau, and Coastal Plain) have soils that vary markedly in physical and chemical characteristics and soil nutrients. As Alabama soil and environmental conditions are never completely alike, the effect on the plant will not be exactly the same. So, adaptability of Basil plant under Alabama soils and environment needs to be further investigated. **Outputs/Impact Statements (Results):** The study was conducted in a greenhouse using soils from Alabama Coastal Plain Areas. Soil was collected and analyzed for morphological and chemical properties before conducting the experiment. The objectives of the proposed research are to: Determine which nitrogen rate produces the highest quantitative yield with respect to total plant biomass. ii. Determine which stage of harvesting during maturity produces the highest quality and quantity with respect to elemental content. iii. Determine if there is any correlation between nitrogen rates and harvesting stages with respect to total plant biomass and elemental content. Training of Undergraduate students with soil sample collection and preparation to conduct experiment, preparing seed beds to grow transplant was accomplished. The first year of the investigation has been completed. Plants were harvested at the different maturity dates and total biomass data recorded for analysis.	
	AAMU Research: Implications of shifting water availability on temperate forest productivity	**Brief Description:** The focus of this project is to conduct applied research with a focus on broadening the available knowledge base on the long-term impacts of changing water availability as related to net primary productivity (NPP) of forest ecosystems. 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. **Outputs/Impact Statements (Results):**	Natural Resource and Environmental Sustainability (#3)

		This study was initiated in the fall of 2020 with budget set up not complete until 11/1. Materials have been ordered for Spring/summer field season. Site selection of landscape level sites has been completed and FIA contacted for required data. Initial contact has been made with National Forest Service for permitting of tree core samples that will be collected in spring and summer 2021. Literature review of target species and historical data has been started and will be complete by Summer 2021. An announcement for the master's students to work on the plot level dynamics has been posted and it is expected that the students will be on board in Summer 2021.	
	AAMU Research: Effects of tillage and residue managements on soil microbial community, carbon dioxide effluxes and soil physical properties in a biofuel sorghum feedstock production system	**Brief Description:** 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. The overall objective of the proposed research is to determine the effects of tillage and residue removal rate on soil health for the biomass sorghum production system in Southeast US region. We have examined 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 carbon dioxide (CO_2) emissions. 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. **Outputs/Impact Statements (Results):** In the sorghum growing season of 2019 and 2020, we started the treatment of tillage and residue return and initially assessed the effects of these treatments on soil health indicators. Treatments are in a random complete block design (RCBD), with 7 different treatments of tillage and residue return and 4 replicates for each treatment included. Exploratory analysis showed interesting patterns that in-row soil CO_2 emission and inter-row soil CO_2 emission had a different peak, and that only non-till treatments with low residue return rates had significant difference in soil CO_2 emission at a few days/stages. ANOVA for RCBD will be done to further tell the effects of treatments. In 2020, we have published a manuscript summarizing our findings on soil CO_2 emissions in previous years (2017 and 2018) in this sorghum field. 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	Natural Resource and Environmental Sustainability (#3)

		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. 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.	
	AAMU Research: Bacterial community structure and biochemical transformation of phosphorus in poultry litter biochar-amended highly weathered soil.	**Brief Description:** Biochar derived from pyrolysis of biomass substrates is a promising soil amendment to sequester atmospheric carbon as well to enhance crop productivity by improving soil properties. Highly weathered soils existing in southeast US are P deficient due to fixation of P in highly insoluble forms. The main objectives include determination of the effects of poultry litter biochar on soil bacterial community structure, study the effect of poultry litter biochar on bio-solubilization of P and determine the effect of poultry litter biochar on soil pH, soil nutrients, and plant growth. This study will provide important fundamental information pertaining to biochemical P transformation and the environmental benefits of poultry litter biochar. The study is focused on the improvement of sustainable agriculture through development of environmentally sound agricultural practices to secure global food production. This study will provide information on how poultry litter biochar can be efficiently used to upgrade soil, increase soil microbiota, and enhance plant growth. **Outputs/Impact Statements (Results):** During this reporting period mainly analyzed our available from data from all our four greenhouse studies using Hartselle and Decatur soils. Our soil analysis data indicated that PLBC applications had effects on changing soil moisture, pH, phosphorus (P), and other nutrient contents. The PLBC application also significantly increased the soil pH of PLBC applied soils at both 0.5% and 1% rates. We identified the bacterial and fungal species present in each of our soil samples. We noted that soils treated with 0.5% PLBC, and 1.0% PLBC held a larger quantity of PSB than untreated control soils, and that soils treated with 0.5% PLBC, and 1.0% PLBC held a larger quantity of PSB than untreated control soils. The addition	Natural Resource and Environmental Sustainability (#3)

		of PLBC catalyzed dynamic changes in the soil microbial structure, creating vastly different bacterial community structures. Besides possible phosphorus-solubilizing bacteria such as Pseudomonas sp., Agrobacterium sp., Bacillus, Azotobacter, and Enterobacter, other microbes identified included isolates of Acidothermus species which are thermophilic, acidophilic, cellulolytic bacteria. The fungal strains identified included Alternaria, Aspergillus, Cephalosporium, Fusarium, and Chaetomium.	
	AAMU Research: Identification and Enumeration of E. coli and the Impact of Climate Change and Variability to determine the Water Quality in the Flint Creek Watershed (FCW)	**Brief Description:** This study evaluates the water quality of the Flint Creek Watershed (FCW), one of the major tributaries upstream of the Tennessee Valley Authority (TVA) Wheeler Dam and Reservoir. The FCW has variously natural and managed land use areas, barren, water, wetlands forest, urban, and agricultural, which have the potential to contribute to the loading in the watershed of organic residues on the land surface that washes off into the receiving waters of the watershed, thus affecting the quality of water and watersheds. Monitoring concentrations of indicator bacteria such as Escherichia coli, assesses the microbiological impairment of water. Research was conducted in the most dominant lands, forest, urban and agricultural areas to identify the impacts of physiochemical parameters (dissolved oxygen, DO, conductivity, pH, and seasonal temperature), which may serve as drivers of E coli. Six (6) water samples from each designated land area within the watershed were taken in triplicate monthly during the 15 month-long study. We hypothesized that E. coli, enumerated using the IDEXX water analysis method, would 1.) exhibit seasonal fluxes during the study and within each land-use area; 2.) illustrate relationships among the land use and 3.) physiochemical parameters. **Outputs/Impact Statements (Results):** Overall, in the samples analyzed for this study, E. coli levels in each land area were higher in the fall, followed by the spring, summer and the lowest concentrations during the winter. The results found that the drivers for the determination of E. coli were temperature and specific conductivity, both of which had positive correlations in each of the three land use areas. Pearson coefficient and p-value statistical data in this study reflected positive relationships between all land-use areas when comparing each of them with E. coli concentrations. Both forest vs urban and urban vs agricultural land assessments are both weakly. However, agricultural vs. forest is strongly correlated and the only exhibited significant relationship of. In addition to the	Natural Resource and Environmental Sustainability (#3)

		findings garnered from the enumeration of E. coli within each land use, these results can be interpreted to mean that within the FCW, urban land although exhibiting higher concentrations of E. coli, weakens the relationships when observed with the other land use areas. Similar to FCW other watersheds with forested areas and stronger interaction between agricultural land use and forest, E. coli composition between these two land types has been found to be relatively homogeneous. Further research, specifically with more sampling data points, will need to be analyzed to determine if this is a factual assertion or is found in other settings. The project has provided opportunities for the training of undergraduate students since its inception to attain training in water quality research. Presentations have been made at Alabama A&M University's annual STEM Day, Association of Research Directors, and the meeting for the American Society of Microbiology.	
	AAMU Research: Evaluating TOR signaling in rapamycin sensitive and resistant plants using transgenic models of Saccharomyces cerevisiae	**Brief Description:** The macrolide antifungal agent rapamycin is produced by the endophytic actinobacterium, Streptomyces hygroscopicus. This antibiotic disrupts signaling of the major cellular growth regulator TOR (target of rapamycin). Although TOR signaling has been investigated extensively in animal cells and fungi, its regulation and activity within plants is not well understood. As well, a thorough evaluation of bioactive plant products with reported rapamycin-like activity is needed in robust systems that can be efficiently assayed. This study explores the ability of turmeric extracts and curcuminoids to affect downstream processes targeted by the TOR signaling network. The mechanisms of rapamycin sensitivity and resistance in plants using transgenic Saccharomyces cerevisiae as a cost-effective rapid model system will also be evaluated. **Outputs/Impact Statements (Results):** The study has identified differential activity of three plant curcuminoids on the TOR signaling pathway in control and fet3D transgenic strains, supporting the ability of bioactive plant products to modulate TOR signaling. Of the curcuminoids assayed, desmethoxycurcumin moderately decreased cell growth and showed greater synergistic effects when used in combination with rapamycin. Bisdemethoxycurcumin treatment, in contrast, decreased cell growth only when TOR kinase activity was inhibited. Curcumin displayed antagonistic activity to	Natural Resource and Environmental Sustainability (#3)

		rapamycin when strains were grown on synthetic complete solid media, but not when grown on YPD solid media, suggesting that curcumin may interfere with rapamycin induced G1 cell arrest under specific growth conditions. Neither yeast strain exhibited sensitivity to turmeric extract, in contrast with previous data using a different isogenic control (minimum inhibitory concentration = 10ug/ml). Deletion of the FET3 gene sensitizes normally resistant yeast to 150uM curcumin. These fet3D cells were hypersensitive to treatment with 150uM curcumin + 10ng/ml rapamycin. The degree of growth inhibition varied in semi-quantitative spot tests and depended on the type of solid media the cultures were grown on. Synchronized populations of control cells displayed a 20-fold decrease in colony counts vs. asynchronous cultures when treated with curcumin alone. Additional analysis of TOR kinase activity, cell cycle disruptions, induction of DNA damage, and a panel of FKBP12 mutations are underway. In the past year, this project has supported the research experiences of 1 undergraduate student who has gained experience in performing molecular biology techniques and designing assays for assessing protein expression. In addition, the project supports the thesis research of 2 Biology Master's degree students, one of whom will complete studies this Spring.	
	AU Extension: Commercial Applicator Virtual Training	**Brief Description:** Due to COVID-19 the Pesticide Applicator University was canceled. This program was designed to offer continuing education points (CEUs) to applicators that would attend this meeting. In conjunction with the Alabama green industry training center, we held 10 free (4 hours each) virtual training events that offered 10 CEUs per event. Target Audience included all Alabama Commercial Applicator Permit Holders. Including Ag Fumigation, Demonstration and Research, Metam Sewer Root Control, Aquatic, Wood Destroying Organisms, Forestry, Household Pest, Ornamental and Turf, Ag Plant, Ag Animal, Aerial, Seed Treatment, Fumigation, Golf Course Permit holders, and all related subcategories. **Outputs/Impact Statements (Results):** Continuing education units (CEUs) issued in 2020 to 903 attendees was 9,030. Each event was worth 10 CEUs. Valued at $270,900 dollars in workforce training allowing applicators to maintain state certification in their respective categories. Engagement= 87% Determined by correct Poll answers issued during virtual training.	Natural Resource and Environmental Sustainability (#3)

	AU Extension: Aquaculture/Aquaponics Education	**Brief Description:** Aquaculture and Aquaponics Education Project (AAEP). For the last 10 years, aquaculture (culturing aquatic organisms in a controlled or semi-controlled environment) has been the fastest growing segment of agriculture growing globally at a rate of 8% year. In the United States, however, that growth has been closer to 1-3%. The US has the appropriate natural resources for growth but lacks an adequately trained workforce to assist in the expansion. In order for the United States to remain competitive, improve food security and provide a safe and healthy protein source for the growing population we must have adequately trained teachers who can produce a competent workforce, skilled practitioners, and aquaculture literate consumers. **Outputs/Impact Statements (Results):** The AAEP used a multipronged approach to reach three distinct audiences, 1) K-14 teachers and students, 2) aquaculture farmers and researchers, and 3) the public. We collaborated with the Alabama Mississippi Sea Grant Consortium, AU professors, and ACES specialists to create a limited use, Canvas Catalog course and provide an intensive 5-day, virtual aquaponics 101 workshop for teachers. Forty-six teachers attended this workshop from 17 states. Based on pre-post testing, the teachers' knowledge about aquaponics increased 32% and resulted in 18 schools implementing new aquaponics curriculum or systems. Based on the post survey teachers felt the knowledge and resources we provided was worth $225, nearly double the price charged for the workshop ($10,350 total). We continue to provide ongoing support for the schools and provide fish to the schools in Alabama. To assist the farmers, researchers, and Extension practitioners around the world we partnered with the US Aquaculture Society and the National Aquaculture Association to produce 8 webinars. Several people attended multiple webinars but the total number of unique registrants for the webinars was 1,961 people from 79 countries. These webinars and subsequent videos were viewed 9,602	Natural Resource and Environmental Sustainability (#3)

		times, providing over 2,500 hours of continuing education for participants and viewers in 2020. A follow up survey with webinar attendees indicated that the average perceived value of the webinar series was $1,719 (or $3.3 million total value). To help educate the public we created several seven new aquaculture related videos that were added to the ACES YouTube Channel and our teams "Aquaculture Education and More" YouTube channel. These videos were collectively viewed 153,438 times providing over 8,486 hours (4.23 FTE - $525,389) of education for people in AL, the U.S. and around the world. The total value of the multidisciplinary aquaculture education program is nearly 4 million dollars, a 40:1 return on investment.	
	AU Extension: The ACES Forage Focus Program: Growing Grass, Growing Profits	**Brief Description:** One of Alabama's greatest resources is its agricultural land. Over 4 million acres of land in Alabama is designated as pasture land or in forage production. It is important that producers adopt practices that improve the overall quality of forage produced on these acres as well as properly care for the land. The Bermudagrass Hay Summit was held as a 1-day workshop for advanced hay producers. This program is conducted for the benefit of experienced hay bermudagrass producers that are committed to growing the highest quality bermudagrass hay possible (usually targeting the horse hay" market). **Outputs/Impact Statements (Results):** Nineteen producers attended the 2020 bermudagrass hay summit. Producers managed an average of 68.3 acres and represented a total of 615 acres. The economic impact was reported as an average of $3,500 per producer. Totaling $66,500 for the program. Producer knowledge increase from an average 2.87 (on a 5-point scale) to a 4.13 and reported a 93% likelihood of adopting some new practices presented at the workshop in the next 12 months.	Natural Resource and Environmental Sustainability (#3)
	AU Extension: The ACES Forage Focus Program: Growing Grass, Growing Profits	**Brief Description:** Forages are one of the most important crops in Alabama, supporting cattle, horse, and small ruminant production across the state. As a result of COVID 19, social media posts and videos became an important avenue to disseminate information to producers.	Natural Resource and Environmental Sustainability (#3)

		Outputs/Impact Statements (Results): During 2020, the ACES Forage Focus Program created 417 unique posts to its Facebook page, which now has 1705 page likes. Within these posts, 49 forge videos and webinars (3-20 min in length) were created by the team and shared through social media. As a result of online efforts, the team reached 13,703 individuals in 2020 compared to only 2,102 reported contacts in 2019, an increase of over 650%.	
	AU Extension: Forestry, Wildlife, and Natural Resources: Promoting and Supporting All Aspects of Natural Resource Management	**Brief Description:** When surveyed, many of Alabama's landowners state that their primary reason for owning land is to pass it on to their heirs, with outdoor recreation and scenic beauty rounding out the top three. Most landowners indicate that they care about the health of their natural resources and want to be good land stewards. Some also state that they would like to generate some revenue from of their land but are unsure how to proceed. Our 2020 program objective was to increase the knowledge level of Alabama's citizens in the area of natural resource management, increase our reach to underserved audiences, and to better understand the impact of our service. To address the forestry, wildlife, and natural resource education needs of Alabama's citizens our 2020 programs included the following topic areas. Community forestry including risk assessment, chainsaw safety, arborist education and beekeeping. Forest management including principles, practices, and stewardship for landowners; professional logging management, forest business resources, alternative income generation, and land management for women and minority landowners. Invasive species identification and control. Water quality and farm pond management. Wildlife management including game and non-game management techniques and wild pig control. **Outputs/Impact Statements (Results):** 1,157 events, 64,694 participants Approximately 621,895 forestland acres owned and/or managed by participants.	Natural Resource and Environmental Sustainability (#3)

		Audience Diversity: 57% Female, 43% Male, 69% White, 27% Black, 4% Other. Our team had a 5% increase in the number of people identifying as Black participating in our events over 2019. We also had a 16% increase in female participants when compared to 2019. Estimated value of service: $171 million. Return on Investment for Alabama Extension: 114:1 Direct Impact of continuing education credits generated: Specialist Leads – Beau Brodbeck, Richard Cristian, Adam Maggard Regional Extension Agent Leads – Ryan Mitchell, Drew Metzler, Norm Haley, Bence Carter, Jack Rowe 5531 Continuing education credits generated. $636,065 participant reported value. Return on Investment for Alabama Extension: 2.6:1 Direct Impact of Forestry, Wildlife, and Natural Resource REA one-on-one contacts: Regional Extension Agent Lead – Bence Carter Supporting Regional Extension Agents – Andy Baril, Norm Haley, Doug Fulghum, Drew Metzler, Ryan Mitchell A short e-survey (using a QR code or Qualtrics link) was developed by FWNR Regional Agent, Bence Carter Using this survey 190 one-on-one contacts were recorded in 2020. 13,558 acres impacted. $37,700 reported value of service Return on Investment for Alabama Extension: 5.8:1	
	AU Extension: Best management practices for Alabama hemp	**Brief Description:** Hemp is a 'new' crop to the United States and Alabama. With little to no research-based information available, growers are turning to sources other than Extension for information on agronomics and pest management strategies. We have an opportunity to make a substantial impact throughout the state and provide our local growers with factual information on hemp production. If this crop is going to be sustainable for fiber, grain, or oil production, farmers need information on best management practices. Therefore, the objectives of this program are to: 1. Increase hemp farmer awareness of Extension resource availability; 2. Document major pests (insects, weeds, and diseases) present in	Natural Resource and Environmental Sustainability (#3)

		Alabama hemp and their impacts; 3. Develop integrated pest management strategies for hemp. **Outputs/Impact Statements (Results):** 41 Extension presentations to growers at in-person and virtual meetings 3 Peer-reviewed Extension publications 4 Articles on the ACES website 6 Webinars 31 samples submitted to the Plant Diagnostic Lab at AU for disease and/or insect analysis. 7 Hemp Production meetings with one scheduled in each SET (the last 2 were cancelled due to COVID-19) with over 500 total attendees. Growers reported saving an average of $106 per field with the educational information provided by ACES. Some growers reported than they saved their entire investment with knowledge gained from the meetings. 89% of respondents at these meetings reported an increase in knowledge gained; 98% said they will use the information from the meeting. Birmingham grower meeting: "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." 3 Virtual Hemp Grower Roundtables with ACES specialists and REAs to recap challenges and lessons learned from the 2020 growing season. 1 On-Farm trial with grower-cooperator field; Insect, disease and weed sampling at 3 grower-cooperator fields. Research trials established at E.V. Smith Research Center and Plant Science Research Center identifying management strategies for fertility, varietal selection, nematode and insect susceptibility, and weed and fire ant control.	
	AU Extension: Weed Management Strategies for AL Cropping Systems	**Brief Description:** The Weed Management Strategies for AL Cropping Systems program is an effort that spans across two Program Priority Teams and includes ACES Specialists, Regional Extension Agents, and County Extension Coordinators who deliver research-based weed management solutions for various Alabama crops. This program is designed to address weed issues in forage/pasture, small grains, corn, soybeans, and non-crop systems across Alabama. Objectives of this program	Natural Resource and Environmental Sustainability (#3)

		include, but are not limited to, educating clientele through demonstrations of research-based agricultural practices, identifying key stakeholders and early adopters who are respected in their community, increasing awareness and adoption of proven integrated weed management practices, and improving profitability through technology adoption. Information is disseminated through individual contacts, social media, periodicals, and Extension outlets such as informative fact sheets and newsletters. **Outputs/Impact Statements (Results):** Key issues and its significance: Multi-year data across the Southeast has shown an average of $380 per acre net return (corn, cotton, soybean) if farmers adopt research-based, proactive weed management practices. Therefore, mitigating herbicide resistance is one of the primary drivers of our research program. Key activities undertaken: A total of 31 weed management field trials were conducted in 2020 with the goal of mitigating herbicide resistance and advocating for BMPs (19 were replicated and 12 were demonstrations). Publications: A total of 12 peer-reviewed publications (6 Extension/2 Research journals/4 conference abstracts (2 regional & 2 national)), 22 articles (9 popular press, 8 newsletters, & 5 ACES Timely Info Pieces), and 6 YouTube videos (1,346 views as of 1/28/21). New technologies available: Our research program supported the state approval of four 24(c) Special Local Needs (crop protection) labels for use of Fierce in Alabama winter wheat. This would apply to 130,000 planted acres of winter wheat (2019 USDA Census) Responses in database: 16 survey respondents Client groups: (cattle and forage producers) 36% full time business, 64% part time business, 47% experienced farmers (>20 years), 21% manage > 200 head of cattle, 43% manage 100-200 acres Change in knowledge/who benefitted: 81% ranked Weed Management presentation as excellent and said they did receive adequate knowledge to implement on their farms, 63% said its extremely likely they will implement practices. Testimonial from one row crop grower implementing our recommendations: "We row crop around 8,000 acres with a rotation of Corn, Cotton, Wheat, Soybeans and Pumpkins. Due to the ever-changing landscape or resistant weeds like Palmer Amaranth as a producer we can get blinded by the simplest of	

		challenges. Little did we know our biggest challenge ahead would become resistant Rye grass…. With the help of Brad Meyer, Green Point Ag, and the recommendation and research from Dr. Russell and his staff at Auburn University Crop Soil and Environmental Science we used a tank mixture of Zidua, Gramoxone and First Shot. To this point we are as clean as we have ever been with typical winter weeds but our start without any resistant Rye Grass is extremely encouraging in our ever-continuing fight. Thank you to Dr. Russell and his team and Auburn University for the research and the much-needed help."	
	AU Research: 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 in the southern forestland	**Brief Description:** 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. Mapped invasive tree species- Chinese tallow (Triadica sebifera) across the southern forestland by using the USDA Forest Service's Forest Inventory and Analysis (FIA) data, developed three conceptual models, and associated statistical models to quantify the spread of invasive Chinese tallow in the stand, landscape, and region levels. **Outputs/Impact Statements (Results):** These models identified significant risk factors related to invasion processes including seed dispersal, seed germination, seedling recruitment and establishment and provided a hierarchical decision-making tool for land and resource managers. The resilience of different forest ecosystems was assessed. Hierarchical models in combination of the quantified invasibility and resilience measures offered a hierarchical framework to understand the mechanisms of Chinese tallow invasion and evaluate the impact. of alternative management scenarios on biological invasion. Target Audience: Foresters, biologists, fire specialists, land and resource managers, and stakeholders in the broad natural resources/forestry areas.	Natural Resource and Environmental Sustainability (#3)
	AU Research Recovery of fish assemblage structure following drought: effects of agricultural land use	**Brief Description:** Both climate change and agricultural land use may change the amount and quality of water available to stream ecosystems. The interaction of these factors has not been considered for stream fishes in Alabama, but a recent catastrophic drought (2016) provides an opportunity to do so. The proposed research promises to not only document the effects of both drought and agricultural land	Natural Resource and Environmental Sustainability (#3)

		use on a gradient of stream sites (headwater to mainstem), but also to investigate a possible mechanism of fish recovery. Initiated projects in partnership with the University of West Florida, Columbus State University, and the University of West Florida. **Outputs/Impact Statements (Results):** investigating how drought (low water availability) may have contributed to the loss of several fish species due to hybrid swamping, completed a project identifying habitat use in high flow areas of the mainstream Tennessee River by Snail Darter, and examined the effects of reduced noise during the pandemic shut down on cortisol levels in fishes. Addition work involves the evolution of hearing in amphibious fishes and a study on fish with different hearing abilities response to extreme noise. pollution. Target Audience: General public, state and federal agencies, students, and the academy.	
	AU Research: Developing Positive Feedbacks Between Agriculture and Conservation of Freshwater Organisms	**Brief Description:** The high biodiversity of native southeastern organisms represents a valuable, but underutilized agricultural resource for new products and low-cost ways to improve water quality in aquiculture ponds (fish farms). Research accessed effects of various stressors such as heat, hypoxia (low oxygen), ammonia, and salinity of the health of mussels and crawfish. **Outputs/Impact Statements (Results):** Respirometry to investigate effects of temperature on energy demand and hypoxia tolerance of two narrowly distributed mussel species, and two subpopulations of a widely distributed. There was no mortality during acclimation and respirometry runs even when mussels were exposed to hypoxic conditions for several hours at 36 °C. However, type and magnitude of sublethal effects varied across species and subpopulations as temperatures increased. A narrowly distributed species exhibited the greatest increase in energy demand, and a decreasing ability to regulate oxygen consumption. Results suggest that effects of increasing temperature on energetic requirements are more important than effects on hypoxia tolerance. Management strategies	Natural Resource and Environmental Sustainability (#3)

		considering physiological differences among species and/or subpopulations are likely to be more effective than a simple “one-size-fits-all” approach. Target Audience: Scientists, students, policymakers, conservationists, aquaculture farmers, and general public.	
	AU Research: Agroclimate Research - Quantification of Nutrient Transport Dynamics in Agricultural Landscapes	**Brief Description:** 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. Quantified the effect of soil physical and chemical properties and infiltrating water chemical properties on pollutants transport processes and simulated the fate and transport processes of pollutants. **Outputs/Impact Statements (Results):** Soil macropore characteristics, including macroporosity, macropore number, interconnectivity, and macropore equivalent diameter as a function of soil depth and slope position were interpreted from X-ray computed tomography within the 50-cm soil profile. Results indicate temporal and spatial variability in macropores. Soil and Water Assessment Tool (SWAT) model management scenarios showed that with soil moisture sensor-based irrigation, cover crop, and strip tillage had the highest potential for reducing nutrient loss and conserving water while maintaining agricultural productivity in Georgia. Target Audience: Scientists, soil, and water conservation agency representatives	Natural Resource and Environmental Sustainability (#3)
	AU Research: Forecasting harmful algal blooms in freshwater systems throughout the southeastern US	**Brief Description:** Water is necessary for our survival, but current environmental challenges have resulted in sporadic toxic cyanobacterial (blue-green algae) blooms. These blooms can kill fish or result in “off-flavor events” and significant economic losses to fish farmers around the world. All 70+ surface water utilities in Alabama are now partners in this research as are many fish farmers. More than 1500 water sample have been obtained and analyzed for the algae and their toxins. Laboratory and field studies have evaluated various chemicals for algae control. **Outputs/Impact Statements (Results):**	Natural Resource and Environmental Sustainability (#3)

		Algal toxins are relatively rare in Alabama surface water intakes. However, algal blooms frequently occur in commercial fishponds. Chemical control of blue-green algal blooms has been effective using hydrogen peroxide (H_2O_2) has proved quite effective. Based on these studies, it is suggested that aquaculture ponds experiencing blooms of blue-green algae be treated with ~7 mg/L dose of H_2O_2 under high ambient sunlight. Target Audience: Scientists, students, policymakers, water utilities, natural resource managers, and general public.	
	AU Research: Biology, physiology, and management of urban arthropod pests in Alabama	**Brief Description:** Urban arthropod pests live in and around our homes and can transmit disease, cause structural damage, and are repulsive to many homeowners. Even though these species are common, there is relatively little information on their behavior, biology, and behavior with which to base management systems. The toxicity of several essential oils was evaluated against three strains (susceptible and two field-collected and insecticide resistant) of German cockroaches. Topical application methods and probit analysis was used to determine toxicity, resistance ratios, and synergism. **Outputs/Impact Statements (Results):** These essential oils killed cockroaches that were resistant to conventional insecticides (permethrin) and could be synergized using Piperonyl butoxide. These studies are the first to identify resistance to some essential oils and the first to report synergism. Mechanisms of conventional insecticide resistance may confer to resistance against some, but not all essential oils. Target Audience: Scientists, students, policymakers, insecticide companies, farmers producing essential oil crops, and general public.	Natural Resource and Environmental Sustainability (#3)
	Tuskegee Research: Calibrated Crop Environment Resource Synthesis	**Brief Description:** Calibrated Crop Environment Resource Synthesis (CERES) maize (corn) and CROPGRO soybean models were used to simulate maize (corn) and soybean physiological growth processes under 2045 and 2075 projected climate change scenarios for six representative counties in Alabama. **Outputs/Impact Statements (Results):**	Natural Resource and Environmental Sustainability (#3)

		The evapotranspiration (ET) rates of each county were assessed by using future climatological emission scenarios, Representative Concentration Pathway (RCP) 4.5 (medium), based on the IPSL-CM5A-MR high resolution climate model. Average corn evapotranspiration increases of 12-42% were respectively projected under RCP 4.5 for 2045, and 8-33% increase in 2075. Soybean average evapotranspiration decreased 11-22% in 2045 and 5-12% in 2075. The variations in ET were largely influenced by an increase in temperature and decrease in precipitation in from corn's April planting date and soybean's May planting date compared to the baseline (1980-2010) evapotranspiration rates. Corn ET in Autauga and Limestone counties produced the highest decrease in 2045 and 2075. Limestone County also produced the highest yield decrease in ET in 2045 and 2075 with Baldwin County being the only county with an ET increase in soybean production.	
	Tuskegee Research: Ecological Conditions Model	**Brief Description:** Longleaf Pine (LLP) forest which once dominated southeastern USA has declined by over 98 percent due to land conversion to commercial plantations of slash and loblolly, widespread fire exclusions and other non-forest land use. **Outputs/Impact Statements (Results):** As part of concerted efforts in the US Forestry Service to restore Longleaf Pines, a spatial Ecological Conditions Model (ECM) was developed to assess the current ecological condition of the LLP ecosystems versus desired ecological conditions for the Tuskegee National Forest (TNF). Model input variables that were identified to influence desired LLP ecological conditions include basal area, stand age and fire frequency. The objectives were (1) to develop variable maps for stand age and fire frequency, (2) Reclassify variable maps and combine variable maps into a single map showing LLP ecological conditions within the TNF in ranked tiers. Data obtained from the Forestry Service was analyzed using Spatial Analyst tools in ArcGIS and results revealed that only a small area (~ 10%) is in good to very good condition where only maintenance activities would be required. About 72 percent of the forest area were found to be in fair/transitional condition that required restoration activities. Results from this research serves as important baseline information to support effective resource allocation for restoration efforts by identifying priority areas.	Natural Resource and Environmental Sustainability (#3)

	Tuskegee Research: Arsenic is a toxicity in soil	**Brief Description:** Arsenic is a toxic heavy metal, which in high concentrations in the soil, can chronically inhibit plant and soil microbial processes. Understanding the effect of arsenic on soil health can be useful in developing technologies for soil remediation. **Outputs/Impact Statements (Results):** The present study was carried out a) To determine the effects of arsenic concentration and type on soil microbial composition and selected soil enzymes, that are important in cycling of carbon and phosphorus (Phosphatase and β-glucosidase Treatments included soils that were treated with Arsenic (III) and Arsenic (V) at three levels (1 ppm, 5 ppm, and 10 ppm) along with a control in a soil microcosm setting. A separate study utilized the known Arsenic accumulators (ferns) Pteris vitatta and Pteris ensiformis in Arsenic-spiked soils at varying concentrations to assess their viability as phytoremediators. Soil samples were assayed for Phosphatase and β-Glucosidase enzyme activity. Phosphatase and β-Glucosidase assays showed that significant enzymatic activity was present at individual levels within the treatments. β-Glucosidase even showed increased activity in the presence of 5 parts per million of Arsenic (III). Pteris vittata sequestered significantly ($p<0.5$) higher arsenic (5,160.6 mg As kg-1) than P. ensiformis (313.4 mg As kg-1). Cellular damage and physiological death occurred in P. ensiformis with alteration in fatty acids and lipid compositions but no significant changes in P. vittata. These results revealed P. vittata phenotypic tolerance to Arsenic stress was mediated through metabolic readjustment, especially its fatty acid and lipid compositions.	Natural Resource and Environmental Sustainability (#3)
	AAMU Extension: Human Nutrition, Diet and Health	**Brief Description:** Due to the COVID-19 Pandemic, residents within North Alabama faced financial hardships and needed support with basic necessities, including food. In partnership with The Legacy Center, a local non-profit that provides services for seniors, and Union Chapel Missionary Baptist Church, Alabama Extension at AAMU coordinated USDA Farmers to Families Food Box distribution efforts in the communities near the campus. Over the course of seven months, 46,900 pounds of food were distributed to over 500 families. Also, to increase consumption of vegetables, the Urban SNAP-Ed team created a six-recipe card set that was distributed 1,550 times. Results from post-program surveys indicated that 84% of	Human Nutrition, Well-being, Health and Obesity (#4)

		respondents found the recipes helpful. Sixty-two percent (62%) also indicated that they prepared the produce in the box using the recipe cards provided. **Outputs/Impact Statements (Results):** The Community Health Aerobic Motivational Program Initiating Optimal Nutrition (CHAMPION) is an ongoing program that encourages Alabamians to get healthy by eating nutrient-rich foods and adding physical activity to their daily routines. Walking Like a CHAMPION is a statewide campaign to get Alabama residents walking. In 2020, the overall CHAMPION program served 224 face-to-face and 2,306 virtual adult participants, who engaged further on Facebook through 23,101 likes, shares, and comments. The Walking Like a CHAMPION program served 752 participants. Respondents logged 3,392,264 steps or 1,696.13 miles. The average time spent walking was 25-30 minutes at least 3 days per week. One hundred seventeen (117) participants also indicated losing between 10-30 pounds (35%).	
	AAMU Research: Characterization and Comparative Analysis of Polylactic Acid vs Polylactic Co-glycolic Acid for Nanoencapsulation.	**Brief Description:** Biodegradable polymers are commonly used as encapsulating agents to protect them from oxidation, light, or adverse environmental condition and improve the controlled release and bioavailability of antioxidants in food systems. The objective of this study was to determine the effectiveness of Polylactic acid (PLA) and Polylactic Coglycolic acid (PLGA) as a carrier for the controlled release of lycopene into the intestinal lumen of the gastrointestinal tract. Method: The lycopene Nanoparticles (NP) were encapsulated with PLA and PLGA by the emulsion evaporation method. The lycopene loaded PLA nanoparticle (LPLAN) and PLGA nanoparticles (LPLGAN) were characterized by differential scanning colorimeter, X-Ray Diffraction (XRD) microscope and Fourier transform-infra red spectroscopy (FTIR), and the average hydrodynamic diameter (HD), Poly-dispersity Index (PDI), and zeta potential (ZP) of the NP were measured using the dynamic light scattering instrument. The lycopene concentration (LC) and encapsulation efficiency (EE) were determined at the following concentrations 10, 20, and 40 mg/100 mL of LPLAN or LPLGAN. **Outputs/Impact Statements (Results):** The optimum values of the HD, ZP, LC, and EE were obtained with the 20 mg /100 mL and 200 mg of PLA concentration. The mean HD and ZP of the LPLAN were 196.67±15.41 nm and -10.9±0.52 mV, while 108.2±2.66 nm and -87.46±3.70 mV	Human Nutrition, Well-being, Health and Obesity (#4)

		for the PLGAN (500 mg) with 500 mg dimethylamine boren, respectively. The PDI was for LPLAN 0.127±0.027 and significantly different ($p < 0.05$) from the LPLGAN (0.207±0.13). The optimized LPLAN EE was significantly ($p < 0.05$) greater than the LPLGAN and better DPPH scavenging effects. The results show that the lycopene encapsulated in PLA has better characteristics and sustainable features for the controlled release kinetics of bioactive compounds. Therefore, LPLAN has a potential application in developing various functional food products in the food industry. Target Audience: Undergraduate and Graduate Student, Research Scientists, Food industry, particularly the functional food manufacturers.	
	AAMU Research: Thermal stability and In vitro Controlled Release Kinetics of Lycopene Nanoparticles in the GIT.	**Brief Description:** Control and targeted release of bioactive compounds over a prolonged period maximize their effectiveness in treating certain conditions. The most effective approach to achieve a controlled release system is by the applications of Nano-encapsulation technologies. It is hypothesized that encapsulating lycopene in PLGA polymer (NP) is ideal for the controlled release. Therefore, the control release mechanism of NP was evaluated. The NP was fabricated using an ultra-sonication emulsification-solvent evaporation technique with an encapsulation efficiency of 87%. Physicochemical properties were characterized using the Dynamic Light Scattering and Scanning Electron Microscope. **Outputs/Impact Statements (Results):** The results show a hydrodynamic diameter (99 nm) of the unloaded NP and while lycopene-loaded NP (LNP) was 103 nm and is spherical with smooth surfaces. The polydispersity index (PDI) (< 0.5) and the zeta potential ranged from -60 mV and -71 mV, hence confirm the slightly dispersed NP and a strong repulsive interparticular force, respectively. The thermo-physical properties revealed significant ($p < 0.05$) thermal stability between LNP (328 °C) as opposed to free lycopene solution (128 °C). The antioxidant assay demonstrated no significant differences ($p > 0.05$) in antioxidant potential between free lycopene solution and LNP, hence encapsulation of lycopene was shown to be effective. The controlled release profiles exhibit a second order, hence an initial burst during the first phase exhibited a rate constant of 4.0 × 10 -4 min-1 during the first 300 min (5 h) followed by a slow and gradual controlled release sevenfold slower at the rate of 1.4 × 10-3 min-1 observed during the second phase.	Human Nutrition, Well-being, Health and Obesity (#4)

		Target Audience: Undergraduate and Graduate Student, Research Scientists, Food industry, particularly the functional food manufacturers.	
	AAMU Research: Evaluation of Health Promoting Properties of Selected Spices and Plant Extracts Against Obesity Induced Diabetes	**Brief Description:** Diabetes is a major epidemic in the US and worldwide. The rise in diabetes is attributed to the rise in obesity as diabetes is a major health complication. Natural and alternative approaches are needed for the prevention and cure of diabetes. This project is focused on evaluation of the potential health benefits of selected spices and plant food components in the prevention of obesity induced diabetes. A targeted group in this research is the adolescent community. Adolescents are becoming increasingly affected by diseases that traditionally occur mostly in adults. Components of the project include chemical analysis of various phytochemicals (to determine antioxidant capacity), development of functional food products and a nutrition education intervention program to impart healthy lifestyle and change dietary behavior of pre- and diabetic adolescents. **Outputs/Impact Statements (Results):** Antioxidant capacity/anti-diabetic properties: One component of the research focused on the antioxidant capacity of garlic, turmeric, and ginger, which suggested that ginger had the highest ferric reducing ability (3,259.00mg Fe2+/100g). The research also determined anti-diabetic potential of spices, in vitro, where turmeric had the highest □-glucosidase percent inhibition (78.85%). Product Development: In this component of the project, 2 products were developed, incorporating various spices and plant protein powders into their formulations. The products were developed with the adolescent community in mind and were evaluated for their possible antioxidant abilities and effect on carbohydrate and lipid metabolizing enzymes. One of the products, 'Spiceola Bites', is a granola-like treat made with garlic, turmeric and ginger. The finished product had a high total phenolic content (1,236.95mg GAE/100g) and was able to scavenge 91.33% of the DPPH free radical. Spiceola Bites also inhibited the lipase (38.84%) and □-glucosidase (64.73%) enzymes, which suggest possible implication of the product in diabetes and obesity prevention. The 2nd product developed was a protein-packed shortbread cookie made with pea, brown rice, and hemp protein powders. Results show that the cookie with 40% protein	Human Nutrition, Well-being, Health and Obesity (#4)

		powder in its formulation was most preferred by sensory panelists and contained various phytochemicals (phenolics, flavonoid) and antioxidant abilities. Survey – Preliminary Nutrition Intervention: The objective of this component of the project was to assess the dietary intake patterns of African American adolescents, with a family history of chronic diseases, via survey. All protocols were approved by the Alabama A&M University Institutional Review Board (Human Subjects Committee). Fifty-two percent of participants stated they almost never or never consumed reduced sugar diets or sugar-free beverages (n= 100). Furthermore, approximately 75% of participants realize when they reach satiety and stop eating (n= 102). However, 14% continue eating after feeling satiated, and 9% rarely realize satiety and often eat too much. Moreover, approximately 56% of participants indicated that they consume spices at least 3 or more times per week. In that, garlic, pepper, ginger, and turmeric were predominant. Results suggest that dietary intervention is necessary to mitigate and reduce disease risk within the adolescent community. Results from this study will be used to develop functional food products targeting adolescents, with the overall goal of increasing antioxidant intake and positively influencing dietary patterns.	
	AAMU Research: The Association of Food Deserts and the Prevalence of Obesity in North Alabama	**Brief Description:** The incidence of obesity and obesity-associated comorbidities is a significant health concern. More than one in three adults are considered obese in the United States. The incidence of obesity in North Alabama is directly influenced by food availability and income. This research will evaluate the impact of food deserts on the prevalence of obesity, on the gut health of individuals that live in food access zones, and its role in modulating critical metabolites produced by select gut associated microbiota. **Outputs/Impact Statements (Results):** The project has identified key determinants associated with food desert areas. These determinants will be used to analyze urban and rural food access zones in key counties identified. A model similar to the one above is currently in preparation delineating the association of food access zones and key determinants as it relates to obesity and health outcomes. Additionally, the impact of carbon on the growth phenotype, morphology, enzymatic activity of catalase, and catabolite repression is being measured. Data from these studies in	Human Nutrition, Well-being, Health and Obesity (#4)

		collaboration with the Biotechnology core of Indiana University School of Medicine will be used to identify specific biomarkers and the pathways involved in their production. Results will provide a greater knowledge of the influence of environmental factors in disease prevalence. This project so far has supported three undergraduate students and one graduate student. In addition, four more undergraduate students have been recruited and will begin training during the Spring 2021 semester. The broader impact will be training minority students in microbial metabolomics and human macrobiotics. Data obtained from the training will be used to target specific biomarkers and the pathways that are involved in production. Results from this project will be presented by both the graduate and undergraduate students will be presented at the annual STEM Day and other scientific meetings.	
	AAMU Research: Assessing Obesity & Hypertension Knowledge, Awareness and Attitudes of undergraduates attending Alabama Agricultural & Mechanical University, a Historically Black College and University.	**Brief Description:** The purpose of this study is to assess Obesity and Hypertension-related Knowledge, Awareness, and Attitudes of undergraduates attending Alabama Agricultural & Mechanical University, a Historically Black College and University. **Outputs/Impact Statements (Results):** The findings of this study will determine the knowledge, awareness, and attitudes of this population concerning obesity and hypertension. If the findings indicate that of obesity & hypertension related know, undergraduates are unaware of the adverse outcomes of obesity and hypertension and the prevention of such outcomes related to health disparities, it will be imperative to procure funding to address these findings in order to educate and train undergraduates, as well as, faculty, staff and the community with reference to the adverse effects of obesity and hypertension and prevention in order to address health disparities in the United States. Finally, if the research findings suggest that undergraduates are unaware of the ominous outcomes of obesity and hypertension at Alabama Agricultural & Mechanical University, a Historically Black College and University, the same may apply to the remaining one-hundred (100) Historically Black Colleges and Universities in the United States, making it imperative to initiate education and training at all HBCU's in order to address healthcare disparities in hopes of preventing obesity and hypertension.	Human Nutrition, Well-being, Health and Obesity (#4)
	AAMU Research:	**Brief Description:** In 2019, heart disease was the number one cause of death in Alabama and Alabama ranked 7th among states in adult obesity (https://www.cdc.gov). These	Human Nutrition, Well-being, Health and Obesity (#4)

	Perception of Madison County Residents on the Benefits and Barriers of Consuming a Vegetarian Diet.	statistics may be directly related to the various health disparities that continue to overwhelm some communities, especially minorities who suffer disproportionately from diet related diseases. Although vegetarian diets have been practiced for years, and is becoming more appealing and accessible, minority communities are not fully informed of the impact of such a diet on health outcomes. Therefore, this study will bring about the awareness to Madison county residents and may help individuals to make more informed health choices. To accomplish the overall objective of the project we: Investigated the knowledge of AAMU and surrounding population on their views on the benefits and barriers of adopting a vegetarian diet. Approximately 550 individuals completed surveys that were distributed to surrounding colleges and community groups. Offered workshop and seminars to educate participants about plant-based eating. In the six (6) workshops that were conducted, community members were educated on nutrition principles and the benefits of plant-based diets. Participants were given the opportunity to taste the various vegetarian foods prepared by faculty and students from the Department of Family & Consumer Sciences. A booklet including tips for healthy eating, along with recipes were developed and distributed at each workshop. Participants were eager to share how these recipes have become a part of their meal planning. In continuation of the plant-based theme, the research team has also offered two seminars, with four others to be scheduled before April 2021. **Outputs/Impact Statements (Results):** In response to survey questions on the benefits of consuming a vegetarian diet, only 25% strongly agreed that a vegetarian diet may be effective in preventing diseases in general. Regarding the barriers, 52% of the participants indicated that they need additional information about a plant-based diet. Overall, the workshops have proven to be successful. While most of the participants were repeat attendees, their enthusiasm in spreading the word about our presence at the Bob Harrison Wellness and Advocacy Center in Huntsville, Alabama, enabled us to welcome new participants at each session. The majority of the workshop and seminar participants were retirees and small business owners, some of whom have been experiencing health challenges. Therefore, they were very receptive to information and stated they were willing to make modifications to	

		their diets to achieve good health. Over 90% of workshop participants agreed or strongly agreed that the information presented in the workshops was useful.	
	AAMU Research: Evaluation of Health Promoting Properties of Selected Spices and Plant Extracts Against Obesity Induced Diabetes	**Brief Description:** Diabetes is a major epidemic in the US and worldwide. The rise in diabetes is attributed to the rise in obesity as diabetes is a major health complication. Natural and alternative approaches are needed for the prevention and cure of diabetes. This project is focused on evaluation of the potential health benefits of selected spices and plant food components in the prevention of obesity induced diabetes. A targeted group in this research is the adolescent community. Adolescents are becoming increasingly affected by diseases that traditionally occur mostly in adults. Components of the project include chemical analysis of various phytochemicals (to determine antioxidant capacity), development of functional food products and a nutrition education intervention program to impart healthy lifestyle and change dietary behavior of pre- and diabetic adolescents. **Outputs/Impact Statements (Results):** Antioxidant capacity/anti-diabetic properties: One component of the research focused on the antioxidant capacity of garlic, turmeric, and ginger, which suggested that ginger had the highest ferric reducing ability (3,259.00mg Fe2+/100g). The research also determined anti-diabetic potential of spices, in vitro, where turmeric had the highest □-glucosidase percent inhibition (78.85%). Product Development: In this component of the project, 2 products were developed, incorporating various spices and plant protein powders into their formulations. The products were developed with the adolescent community in mind and were evaluated for their possible antioxidant abilities and effect on carbohydrate and lipid metabolizing enzymes. One of the products, 'Spiceola Bites', is a granola-like treat made with garlic, turmeric and ginger. The finished product had a high total phenolic content (1,236.95mg GAE/100g) and was able to scavenge 91.33% of the DPPH free radical. Spiceola Bites also inhibited the lipase (38.84%) and □-glucosidase (64.73%) enzymes, which suggest possible implication of the product in diabetes and obesity prevention. The 2nd product developed was a protein-packed shortbread cookie made with pea, brown rice, and hemp protein powders. Results show that the cookie with 40% protein	Human Nutrition, Well-being, Health and Obesity (#4)

		powder in its formulation was most preferred by sensory panelists and contained various phytochemicals (phenolics, flavonoid) and antioxidant abilities. Survey – Preliminary Nutrition Intervention: The objective of this component of the project was to assess the dietary intake patterns of African American adolescents, with a family history of chronic diseases, via survey. All protocols were approved by the Alabama A&M University Institutional Review Board (Human Subjects Committee). Fifty-two percent of participants stated they almost never or never consumed reduced sugar diets or sugar-free beverages (n= 100). Furthermore, approximately 75% of participants realize when they reach satiety and stop eating (n= 102). However, 14% continue eating after feeling satiated, and 9% rarely realize satiety and often eat too much. Moreover, approximately 56% of participants indicated that they consume spices at least 3 or more times per week. In that, garlic, pepper, ginger, and turmeric were predominant. Results suggest that dietary intervention is necessary to mitigate and reduce disease risk within the adolescent community. Results from this study will be used to develop functional food products targeting adolescents, with the overall goal of increasing antioxidant intake and positively influencing dietary patterns.	
	AU Extension: Auburn University Supplemental Nutrition Assistance Program – Education (AU SNAP-Ed)	**Brief Description:** Alabama Extension at Auburn University Supplemental Nutrition Assistance Program – Education (AU SNAP-Ed) used an evidence-based, multi-level approach to create a healthy population. The flagship school-based initiative is Body Quest, a multi-level obesity prevention initiative, which empowers Alabama's youth to make healthier choices, and engages parents in learning and behavior changes alongside their children. In addition, AU SNAP-Ed facilitated local and state Policy, Systems and Environmental (PSE) changes to make it easier for limited resource individuals to choose healthy foods and beverages and physically active lifestyles. To complete the levels, AU SNAP-Ed developed an original social marketing initiative, Live Well Alabama, to reach its target audience through social media, outdoor and digital advertising, and text messaging. The campaign integrated SNAP-Ed resources into local communities and home environments to increase awareness of better food and drink choices and increased motivation for daily physical activity. The target audience eligible to receive nutrition education and obesity prevention services continued to focus on SNAP participants and low-income individuals	Human Nutrition, Well-being, Health and Obesity (#4)

		eligible to participate in SNAP, and individuals residing in communities with a significant low-income population. SNAP-Ed is a grant-funded initiative with an annual budget in excess of $6M. Additionally, SNAP-Ed employs more than 60 individuals in primarily rural areas of the state with positions that pay a living wage and provide benefits, such as comprehensive health care. **Outputs/Impact Statements (Results):** AU SNAP-Ed reached 16,210 adults and 15,424 youth with 4,533 direct nutrition education classes. In addition, 51,560 people were impacted through PSE changes to improve healthy environments in Alabama. Forty-two Extension publications were created for educational purposes, and 13 refereed research abstracts and publications were created to disseminate the positive work being completed by AU SNAP-Ed staff. Results of a pre-post impact assessment (treatment vs. control) statewide evaluation show significant differences in evaluation of direct education. Direct education – nutrition and physical activity instruction Increased fruit and vegetable consumption Increased variety of vegetables consumed. Increased water consumption Decreased sugar sweetened beverage consumption. Decreased sedentary activity participation. Increased intensity of physical activity participation Increased food resource management behaviors among parents Increased purchasing of low-fat milk Increased purchasing of low-fat dairy Increased purchasing of low added sugar products Increased purchasing of low added salt products Increased low-fat milk consumption. Policy, Systems and Environmental (PSE) changes and reach 31 improvements in 23 parks and recreation centers in 13 counties reaching 14,689 residents per day. 18 improvements in 10 food retail outlets in 7 counties reaching 2,142 customers per day.	

		75 improvements in 28 gardens in 18 counties reaching 6,828 residents throughout the year. 26 improvements in 14 farmers markets in 9 counties reaching more than 3,390 customers per market day. 32 improvements in 15 emergency food assistance sites in 12 counties reaching 9,809 food pantry clients per month. 160 improvements in 85 schools in 33 counties reaching more than 37,414 students throughout the year. Social marketing numbers and analytics Live Well Alabama messages of Eat Better, Move More and Make a Change blanketed the state through a social marketing campaign including billboards, digital ads, and social media. For 28 weeks, 159 billboards in 50 counties displayed each of the three messages, changing every 4 weeks. Billboards made over 146 million impressions. Digital advertisements made over 8 million impressions and drove viewers to visit the Live Well Alabama Facebook page more than 13,000 times. Social media following grew by 25%. Facebook alone reached more than 240,000 people. More than 6,500 people participated in text messaging campaigns. Selected COVID-19 effort AU SNAP-Ed partnered with End Child Hunger in Alabama to create the County Food Guides (aub.ie/food guides), an online interactive map detailing available food resources by county, such as school meals, food pantries, retailers accepting SNAP, and farmers markets available to Alabama residents. Educators maintained and updated this crucial information for 50 counties, benefiting 421,276 SNAP participants in the state.	
	AU Extension: Auburn University Expanded Food and Nutrition Education Program (AU EFNEP)	**Brief Description:** AU EFNEP teaches limited-resource audiences, through a series of lessons, primarily in small groups, how to improve dietary practices and become more effective managers of their available resources. The overall goal of AU EFNEP is to aid limited-resource audiences in acquiring knowledge, skills, and changed behavior necessary for nutritionally sound diets and to contribute to personal development and the improvement of the family diet and nutritional well-being. The target audience for AU EFNEP includes:	Human Nutrition, Well-being, Health and Obesity (#4)

		Limited resource parents and other adult caregivers who have responsibility for feeding young children. Limited-resource children and youth Limited-resource pregnant teens and women The target audience is recruited and enrolled in places where limited-resource families live, work, and frequent. Such places include local housing authorities, county health departments, Department of Human Resources, Head Start, food banks, family resource centers, schools, work sites, hospitals, and community action agencies. AU EFNEP is a grant-funded initiative with an annual budget in excess of $1.9M. Additionally, AU EFNEP employs 30 individuals in primarily rural areas of the state with positions that pay a living wage and provide benefits, such as comprehensive health care. **Outputs/Impact Statements (Results):** AU EFNEP reached 1,333 adults and 5,787 youth with 6,986 nutrition classes in 385 delivery sites. Indirect contacts were made with 119,399 individuals. In addition, 215 volunteers donated 1,838 hours to AU EFNEP programming, and 292 community partners worked with AU EFNEP to improve dietary practices of Alabama adults and youth. Adult Food and Physical Activity Behavior Questionnaires and 24-hour dietary recalls, administered at program entry and at program exit, measure change in adult behavior. Findings for adults: 95.3% showed positive change in any food group at exit (fruits, vegetables, grains, protein foods, dairy) 83% showed improvement in one or more food resource management practices (i.e., cook dinner at home, compare food prices, plan meals, make a list before shopping) 94% 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 at home) 82% 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) 47% showed improvement in or 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) 82% 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) Youth Food and Physical Activity Evaluation, administered at program entry and at program exit, measure change in youth behavior. Findings for youth: 91% improved their ability to choose foods according to Federal Dietary Recommendations or gained knowledge. 67% improved their physical activity practices or gained knowledge. 62% use safe food handling practices more often or gained knowledge. 55% improved their ability to prepare simple, nutritious, affordable food or gained knowledge.	
	AU Extension: Diabetes Empowerment Education Program (DEEP)	**Brief Description:** Approximately 610,458 people in Alabama have diabetes. Diabetes and prediabetes cost an estimated $5.4 billion in Alabama each year. Some of the serious complications, such as amputations and blindness, can be managed. The Diabetes Empowerment Education Program (DEEP) is implemented by 8 Extension Peer Educators or Lead Trainers in six-week sessions. These sessions give participants the necessary knowledge and skills for diabetes self-management. 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. Participants learn about portion control, label reading, choosing carbohydrates wisely, monitoring your A1C number and comprehensive foot care recommendations. The content of the curriculum is presented in activities applying adult education methods.	Human Nutrition, Well-being, Health and Obesity (#4)

		Outputs/Impact Statements (Results): DEEP was delivered statewide. Of the 178 participants, 152 were females and 26 were males: 102 were African America, 12 American Indians, 52 white, 10 Hispanics and 2 more than one race. Based on SAS outputs, DEEP training participants made significant knowledge gains and positive behavioral changes from pre- to post-assessments. From pre- to post-assessments, significantly more participants understood (a) physical activity lowers blood sugar levels and (b) looking and washing your feet each day. From pre- to post-assessments, significantly more participants started washing and looking at their feet every day. These changes can help prevent foot problems associated with diabetes such as amputation by 45-85%.	
	AU Extension: Breastfeeding Friendly Child Care	**Brief Description:** Alabama ranks in the bottom, nationally, for implementation and continuation of breastfeeding. Yet breastfeeding is associated with decreased risks for developing childhood obesity and developing type 1 or 2 diabetes for children. Mothers that choose to breastfeed are at decreased risks of developing type 2 diabetes and high blood pressure. The Alabama Breastfeeding Friendly Child Care program aims to increase knowledge and application of breastfeeding best practices among childcare providers by utilizing direct education, policy change and hands-on application. After completing face-to-face, the initial training, childcare providers receive training on the requirements to become breastfeeding friendly. In order to become a Breastfeeding Friendly Child Care Certified Center, there are policies, environmental changes and system changes that providers must implement within their programs. A site visit is included to verify that all requirements are being met. Two continuing education hours are available. **Outputs/Impact Statements (Results):** The Alabama Breastfeeding Friendly Child Care certification reached 305 adult childcare employees in 35 homes/centers. All 35 providers have implemented and maintained environmental changes as well as create updated current policies to provide evidenced-based care to better support breastfeeding families their program. More than 1,200 children under the age of five attend the programs of the certified providers. These children see books with images of nursing mammals, posters of mothers breastfeeding, and moms encouraged to nurse on site. This normalizes breastfeeding in a state with below average breastfeeding	Human Nutrition, Well-being, Health and Obesity (#4)

		rates. This certification is recognized by the Alabama Department of Public Health. While the Breastfeeding Friendly Child Care Certification maintained its presence and credibility, the COVID-19 pandemic did have a substantial impact on new certifications for the 2020 programmatic year. Due to childcare closures, economic stress, and limited capacity for many providers to simply stay in business, there were fewer opportunities to train and certify new childcare providers.	
	AU Research: Promoting Relational Health Among Limited Resource Parents	**Brief Description:** Determining the effectiveness of couple/relationship education programs for limited resource, ethnically diverse parents aimed at strengthening family life (i.e., individual well-being, couple functioning, coparenting functioning, parenting, and child outcomes). Data collection over a 2 year follow up period was completed. Those receiving programming were compared to a control group not receiving programming. Analyses addressed measures of individual well-being, couple functioning, coparenting functioning, parenting, and child outcomes; comparative benefits of two different forms [Elevate program compared with Couples Connecting Mindfully (CCM)] of the couple/relationship education program. **Outputs/Impact Statements (Results):** Multilevel growth modeling results revealed a statistically significant ($p < .05$) difference in average growth over one year between program participants and the control group in each of the domains of functioning indicating program impact. The Elevate program was associated with differences compared to the control group on all but one of the outcomes; CCM showed differences from the control group on half of the outcomes assessed. These results were included in a proposal for another 5-year cycle of external funding from the U.S. Dept of Health and Human Services; notice of award was received the end of September 2020. Target Audience: Scientists, students, policymakers, health professionals, and the general public.	Human Nutrition, Well-being, Health and Obesity (#4)
	AU Research:	**Brief Description:** Elucidating changes in the strength of the association between childhood SES and adult health, and systematically examining reasons for these changes. The	Human Nutrition, Well-being, Health and Obesity (#4)

	Secular Trends in the Association between Childhood Circumstances and Adult Health	overarching goal is to provide insight into policy solutions to reduce social stratification of health outcomes. National data from four complementary sources were used to address associations among childhood circumstances and adult health. Specifically, longitudinal, cohort sequential, and repeated cross-sectional data were used to examine recent historical changes (secular trends) in the strength of the association between childhood SES and adult health. **Outputs/Impact Statements (Results):** Results indicated that the association between childhood disadvantage and all five adult health outcomes was stronger in the 2012 sample than the 1995 sample, with the magnitude of associations being approximately twice as large in the more recent sample. Results persisted after adjusting for age, sex, race, marital status, and number of children, and were similar across all three measures of childhood socioeconomic disadvantage. Overall, the findings suggest that the socioeconomic circumstances of childhood may have become a stronger predictor of adult health in recent decades. Target Audience: Policymakers, scientists, students, health professionals, and the general public.	
	AU Research: Reducing E-Health Literacy Disparities among Rural Elders Using Intelligent Agent Technology	**Brief Description:** Addressing rural elderly health with consumer-friendly technology with a specific focus on Medicare Plan Finder. With the goal of designing an AI agent with the capability of aiding older adults' Medicare plan selection decisions, the project team launched an observation study in which a sample of 29 older adults were observed while they were selecting a Medicare drug plan using the online Medicare Plan Finder (MPF), an e-health decision support tool provided by Medicare.gov. MPF through medicare.gov offers a venue for older adults to obtain information and compare Medicare plans. Next, the project team set out to identify older users' challenges in employing optimal decision strategies on MPF and areas they desire an AI agents' assistance. In partnership with Alabama's SHIP and AAC at Opelika Sportsplex, older adults were recruited and paired with trained Medicare counselors and performed the task of selecting their Medicare drug plan using MPF. The counselor-participant conversations were audio-recorded while the participants' MPF task screens were video-recorded. In addition, the participating older adults, and their counselors both completed questionnaires which assessed their experiences during the task.	Human Nutrition, Well-being, Health and Obesity (#4)

		Outputs/Impact Statements (Results): From the first study, despite the availability of MPF, it was found that most older adults either do not reevaluate their plans or choose sub-optimal plans due to the complexity of the insurance structure consisting of numerous attributes and the abundance of alternative plans in competition. This suggests a need for on-screen, real-time, on-going decision assistance embedded in MPF to enhance older users' ability to make optimal plan decisions. For the second study, findings from the screen video, conversation transcript, and questionnaire data provided rich insights into older users' challenges in using MPF. For example, participants were focused on the cost aspects of the plans (e.g., premium, deductible, overall out-of-pocket cost), but paid less attention to the coverage of the plan (e.g., what drugs are covered, what geographic locations and pharmacies are covered, what other health benefits are covered) when choosing their Medicare plan. Counselors' assistance also tended to focus on the plan costs in response to participants' frequent cost-related inquiries. These observations suggest that AI agents on MPF must enlighten older users on diverse plan attributes beyond just the cost aspect. Target Audience: Health professionals, scientists, students, policymakers, and general public.	
	AU Research: Obesity-linked Diabetes, Cancer, and Alzheimer's Research	**Brief Description:** Nonalcoholic steatohepatitis (NASH) is linked to cancer, yet there are no specific therapeutic treatments for NASH. To move toward identifying such treatments, this research aims to develop new models to examine the role of putative genes in the progression to NASH and examine the colorectal tumor growth promoting effects of profibrotic hepatocytes. Established an in vitro model for colorectal cancer. The cells from CRC-PDX tumors can be successfully encapsulated in a biomimetic, hydrogel material, PEG-fibrinogen, and maintained in vitro in long-term culture; the 3D engineered CRC-PDX tissue microenvironment supports robust in vitro CRC-PDX tumor cell culture. **Outputs/Impact Statements (Results):** Results were highly replicable, demonstrating consistent high viability, proliferation, and growth of encapsulated cells. The 3D-eCRC-PDX tissues and CRC-PDX tumors demonstrated similarity in enriched gene ontology molecular	Human Nutrition, Well-being, Health and Obesity (#4)

		functions and Hallmark gene sets and did not reveal a significant difference for prognostic Kaplan-Meier plots for overall survival and relapse-free survival. Furthermore, the 3D-eCRC-PDX tissues showed similar ECM proteins and mimicked the mechanical stiffness of the originating CRCPDX tumors, as well as published data for patient CRC tumors. Target Audience: Scientists, students, policymakers, health professionals, and general public.	
	AU Research: Nerve Growth Factor and its Receptor TrkA in Insulin Signaling	**Brief Description:** To understand how Nerve Growth Factor and its receptor TrkA (NGF-TrkA) influences insulin signaling in the brain and its function in inducing insulin secretion from pancreatic beta cells. Specific aims were to (a) establish the role of NGF in controlling glucose metabolism and diabetes mellitus, and (b) determine whether nasal delivery of NGF reduces blood glucose levels in STZ-treated diabetic mice. Completed the animal studies and used 48 mice; used 12 control (non-diabetic), 12 NGF-treated (nasal delivery treatment), 12 STZ-treated (diabetic) and 12 mice were treated with both NGF and STZ. Blood samples were obtained at regular intervals from a carotid cannula and blood plasma was separated and analyzed for active and total glucagon-like-peptide-1 (GLP-1) using enzyme-linked immunosorbent assay (ELISA). The oral glucose tolerance test (OGTT) was determined in control and STZ-treated animals after given glucose (1.5 mg/g body weight) containing NGF or insulin or both to see whether NGF stimulates glucose disposal. Blood glucose was determined using a glucose analyzer. The plasma insulin levels were determined using a specific insulin radioimmunoassay kit. **Outputs/Impact Statements (Results):** Overall, NGF treatment reduced the diabetes and Alzheimer disease markers in the mouse brain. Target Audience: Scientists, students, policymakers, health professionals, and general public.	Human Nutrition, Well-being, Health and Obesity (#4)
	AU Research: The role of omega-3 derived pro-resolving lipid mediators on	**Brief Description:** To understand the mechanism by which omega-3 polyunsaturated fatty acids (PUFA) may be having a neuroprotective effect against cognitive decline associated with diabetes.	Human Nutrition, Well-being, Health and Obesity (#4)

	neuronal inflammation in a diabetic mouse model	This research tests whether omega-3 fatty acids are exerting their neuroprotective effects through resolution of inflammation. Specifically, specialized lipid mediators derived from omega-3 fatty acids are anticipated to be generating cellular signals that increase pro-resolution pathways leading to decreased inflammation associated with neuronal decline. Hippocampal brain samples from high fat/high sugar fed mice (HFS;16 weeks) were isolated and lipid extracted for fatty acid and lipidomic analysis. **Outputs/Impact Statements (Results):** In the preliminary fatty acid analysis, the percent of total phosphatidylethanolamine (PE) signal from DHA containing PEs was decreased in the HFS group compared to the control from an average of 31.7% to 30.6%. The percentage of the PC total containing DHA was decreased from 5.86% to 5.50% ($p < 0.05$). The lipidomics data suggest that the high fat diet group may have a lower amount of DHA incorporated into hippocampal cell membranes, which is in agreement with other studies. This may contribute to cognitive. impairment and inflammation, which will be further assessed in the fish oil supplementation study and may be ameliorated by the DHA containing fish oil supplement. Target Audience: Scientists, students, policymakers, health professionals, and general public.	
	AU Research: Leptin: A Probe to Help Understand the Regulation of Blood Glucose Concentrations During Diabetes	**Brief Description:** To examine whether pharmacological manipulations of metabolic processes will elucidate the mechanism by which chronic central leptin administration normalizes blood glucose concentrations independent of insulin in an animal model of type 1 diabetes. Sixteen Wister rats were implanted with an intracerebroventricular (ICV) cannula directed into the lateral ventricle of the brain. Eight rats were treated with streptozotocin (STZ) to induce type 1 diabetes. Once hyperglycemia was established in these rats, they began to receive daily ICV injections of leptin. The other eight rats received control injections and served as controls. To determine whether leptin was having an effect in the diabetic rats, a 6-hour fast in all animals was performed. **Outputs/Impact Statements (Results):**	Human Nutrition, Well-being, Health and Obesity (#4)

		Blood glucose concentrations of STZ-treated (diabetic) rats increased to over 500 mg/dl. Daily leptin treatment reduced blood glucose concentrations to approximately 200 - 250 mg/dl after 10 days of leptin treatments but appeared to stabilize around this level after this. Baseline blood glucose concentrations in STZ-treated, leptin-treated rats averaged just under 300 mg/dl. Baseline blood glucose concentrations of the control rats averaged just over 100 mg/dl. Fasting caused a rapid decrease in the glucose concentration of the leptin-treated rats. After 4 hours of fasting, the blood glucose concentrations of the two groups were equal, and by 6 hours of fasting the blood glucose concentration of the leptin-treated rats were significantly lower than in the control animals (69 ± 11 vs 116 mg/dl ± 3). This indicated that leptin was able to normalize or reduce blood glucose concentrations in the diabetic animals. Target Audience: Scientists, students, policymakers, health professionals, and general public.	
	AU Research: Adolescent and Young Adult Experiences Leading to Persistent Alcohol Use Disorder, Depression, and Comorbid Alcohol Use Disorder and Depression in Young Adulthood	**Brief Description:** To understand problematic alcohol use and associations with anxiety and depression among adolescent and young adults in Alabama. A comprehensive survey assessment of college students as they made the transition in the first and second years of college and at the point of transition out of college was conducted. **Outputs/Impact Statements (Results):** There was an increase in the prevalence of those that met the clinical threshold for both alcohol use disorder and depression, from the first (wave 1) to second (wave 2) year of college to the transition out of college (wave 3). More women than men met the threshold for both alcohol use disorder and depression at waves 1 and 2, but proportions were similar at wave 3. As planned analyses continue, this research will help 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. Target Audience: Educators, scientists, students, policymakers, health professionals, and general public.	Human Nutrition, Well-being, Health and Obesity (#4)

	AU Research: Context Effects on Adolescent Risky Decision Making: A Multi-level Approach	**Brief Description:** The need to address adolescents' risky decision-making that affects real-world risk-taking behavior and threatens health and well-being. Experiments were conducted that tested effects of different contexts/rewards on adolescents' risky decision-making in driving behaviors. **Outputs/Impact Statements (Results):** Rewards favoring safe choices reduced risky decision making, but this effect was especially robust for adolescents with driving styles that increase risk of motor vehicle crashes (i.e., dangerous, fast, angry, or distracted styles). Findings suggest that rewards for safe driving can be an effective mechanism for reducing motor vehicle crashes, especially for the most at-risk drivers, if they can be made appetizing to adolescents. Target Audience: Scientists, students, policymakers, educators, and general public.	Human Nutrition, Well-being, Health and Obesity (#4)
	AU Research: Promoting Alabama Occupational Worker Safety and Health through Personal Protective Equipment with Emerging Technologies	**Brief Description:** PPE (e.g., protective clothing, respirator, glove, hat) needs of Alabama occupational workers in hazardous and high-stress environments to improve the protection, fit, comfort, durability, functionality, and mobility of PPE along with its use, care, and maintenance. An online survey was conducted with a sample of 200 healthcare professionals focusing on PPE for body protection, including scrubs (tops/pants), gown, coverall, and disposable or reusable aprons for health care workers. Open-ended questions addressed challenges healthcare workers face while wearing PPE; close-ended questions asked about PPE use, maintenance, and opinions of its features including fit, mobility, comfort, donning and doffing, and aesthetic. Data from the open-ended questions were analyzed using content analysis; quantitative data were analyzed using basic descriptive statistics and frequencies. **Outputs/Impact Statements (Results):** The findings revealed needs for PPE improvement in terms of fit, comfort, mobility, and donning and doffing for Health care workers' safety and health. This study also reveals that most healthcare workers dispose of their PPE in a trash can in a healthcare unit and non-disposed PPE is laundered at home, which may expose their family members to a health risk if a proper precaution is not	Human Nutrition, Well-being, Health and Obesity (#4)

		followed. These findings show further that the post maintenance of PPE after its use often has not been properly instructed in a job site, which leads to critical concerns about the exposure to contaminated PPE in various locations. Target Audience: Health professionals, scientists, students, policymakers, educators, and general public.	
	Tuskegee Research: African American foodways and heritage cooking	**Brief Description:** The food we eat and the stories that surround it speak volumes about who we are and where we come from. Systemic racism has confounded this issue to tell dark and shameful narratives about African American people and the food they choose. It is important that the myths that surround African American foodways and heritage cooking (i.e., Soul Food) be investigated and exposed. This presentation will make connections between food systems narratives and racial injustices as well as describe the role that culture plays in making sustainable changes. **Outputs/Impact Statements (Results):** A qualitative multiple case study approach using in-depth, open-ended semi-structured interviews (N=3) with African American Soul Food experts was conducted. Known figures within the Soul Food community were invited to give guidance to the project. I utilized snowball-sampling methods to recruit participants in the study as this strategy allows the researcher to gain access to individuals who may otherwise remain inaccessible (Woodley & Lockard, 2016). This study explored the association between African American Heritage Cooking (AAHC) and sociocultural wellness among African American adults in the United States. It was discovered that the participants felt that Soul Food contributed to the survival of social and cultural institutions. The study participants suggested four factors that contributed to the theme of healing which were: (a) equity, (b) health, (c) shame, and (d) survival. Many of the participants felt Soul Food was a part of their heritage and their choice to produce and consume such foods was a means of declaring their freedom from white supremacy. Overall, all participants agreed that AAHC was vital to the overall wellness of Black communities in terms of health, social, and cultural values. This work sets a framework for integrated research and extension that emphasizes cultural affirming and healthy food choices for African Americans.	Human Nutrition, Well-being, Health and Obesity (#4)

	Tuskegee Research: Micronutrient deficiencies	**Brief Description:** Micronutrient deficiencies caused by lack of Iron (Fe), Zinc (Zn) and Vitamin A in the human body have negative effect with regard to health issues worldwide. Imbalances of these nutrients in the human body create a significant risk of illness and mortality among children under five years of age, pregnant women, and lactating mothers. Despite the fact that dry beans address Fe and Zn deficiencies based on recommended dietary allowances (RDA), they often take a long time to cook. **Outputs/Impact Statements (Results):** This study identified dry bean cultivars with enhanced Fe and Zn concentration levels and fast cooking time from 200 cultivars. Iron and Zinc concentration levels were determined from the harvested seed grains of each bean cultivar while cooking time of similar cultivars were determined using the Mattson cooker. The variation of Fe and Zn concentration was significantly different at ($p<0.001$) among the treatments and environments. The highest water uptake was 61.54% and the lowest was 3.70% and the higher the water uptake the lower the cooking time. Fast cooking time was ~15 min and the longest was ~76 min. Small seed-sized cultivars showed fast cooking time than large-seeded. These two traits in identified cultivars will enhance dry bean consumption, which will contribute to alleviating micronutrient deficiencies in this global growing population.	Human Nutrition, Well-being, Health and Obesity (#4)
	AAMU Research: A Multiple-Pronged Attack on Quackery and Nutrition Misinformation to Reduce Obesity Rate in Alabama.	**Brief Description:** People in our communities are still being deceived by quackery and nutrition misinformation by unscrupulous individuals who want to make money by all means, through false advertising on TV, News Papers, Radios, and other social media outlets. This misinformation has resulted in individuals adopting various diets and using their resources for unproven food and nutrition advice and products. **Outputs/Impact Statements (Results):** To satisfy objective 1 of these projects, questionnaires were distributed in Alabama and other States around the nation. For objective 2, the project team developed a brochure that outlines the science and nutrition-based approaches to reduce incidences of obesity in Alabama and beyond. Lifestyle that incorporates physical activities and adequate hydration with water, rather than heavy caloric sodas and alcohol is a highlight in the	Community Development (#5)

		brochure. Another focus is on the recommended DASH diet (Dietary Approach to Stop Hypertension). As part of the impact, people in the community are taking heed in reading food labels before they buy food products from the grocery stores. Community members now have a better understanding of the health consequences of morbid obesity. They recognize that bariatric surgery is not the answer to restoring good health. In the study, we reinforced the importance of consulting with health professionals such as Registered/Licensed Dieticians and other health care providers.	
	Tuskegee Extension: Future Farmers and Agricultural Specialists	**Brief Description:** 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. **Outputs/Impact Statements (Results):** 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 yearlong apprenticeship. Students spent time working alongside farmers, extension agents' professionals, agribusiness entrepreneurs, and community-based organizations while learning their craft. There were also mandatory courses in Geographic Information Systems and Sustainable Food Systems delivered with weekly workshops/seminars. Of the 40 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 78% increased their knowledge in the use and application of Geographic Information Systems. 90% of the participants indicated an increased likelihood to pursue a profession in agriculture and related sciences.	Community Development (#5)
	Tuskegee Extension: Small Business Sustainability	**Brief Description:** 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	Community Development (#5)

		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. **Outputs/Impact Statements (Results):** Faced with the other accompanying challenges of the pandemic, TUCE decided to design virtual summits to address the needs of Black Belt small businesses. The first of the two summits were the Rural Prosperity Summit, done in partnership with USDA-OPPE. This summit was organized in three days around the themes 1) Achieving E-Connectivity in Rural America, 2) Improving Quality of Life/Developing the Rural Economy, and 3) Supporting a Rural Workforce/Harnessing Technological Innovations. The second of the two summits were the Annual Booker T. Washington Economic Development Summit. Another three-day virtual event, this one focused on small businesses survival the new normal through 1) Access to Capital, 2) Digital Marketing, and 3) Risk Management. The summits together produced 345 participants mainly located in the AL Black Belt (62%), but from 7 other states as well. The RPT was 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.	
	AAMU Extension: Family and Child Development	**Brief Description:** Mandates requiring social distancing and sheltering-in-place as a measure for stopping the spread of the coronavirus have worsened already disconcerting public health issues for older adults –social isolation, loneliness, and onset of dementia. In response to these growing problems, Alabama Extension at Alabama A&M University developed an online training program to teach older adults how to use Zoom to stay connected to family and friends. The three-session training consisted mainly of experiential learning activities. Outputs/Impact Statements (Results):	Family, Home, and 4-H and Youth Development (#6)

		A total of 232 older adults were trained in how to participate in Zoom meetings as well as host Zoom meetings. Many of the participants used their acquired skills to stay socially engaged. They participated in and organized events such as Bible studies, family gatherings (birthday parties, family reunions, etc.) and voter registrations. Also, 3,852 grab bags were distributed in four Alabama Counties. The bags consisted of activities that promote cognitive health, as well as information sheets relating to topics such as fall prevention, assistive devices, fraud and scams, estate planning basics, and spending plans.	
	AAMU Extension: 4-H Youth Development	**Brief Description:** Urban Regional Extension Agents for 4-H & Youth Development delivered a series of 5 interactive and engaging Science, Technology, Engineering, Agriculture, and Math (STREAM) lessons virtually to 843 participants. Topics included understanding STEM concepts (coding, robotics, chemical changes), differentiating STEM careers (i.e., engineers, pilots, and scientists), and STEM skill development (problem-solving, measuring, hypothesizing, working collaboratively, analyzing results & drawing conclusions). Post-session evaluations indicated that many youths were able to accurately and logically apply the steps of the scientific method, define computer programming skills and properly use coding applications. **Outputs/Impact Statements (Results):** At the program's completion, 72% more youth felt studying science was fun and 66% of youth reported having high or greater knowledge of using the scientific method to conduct science experiments. Eighty seven percent (87%) reported have an interest in pursuing a STEM related career. Additionally, female participants showed high levels of engagement in STREAM activities, specifically coding.	Family, Home, and 4-H and Youth Development (#6)
	AU Extension: Escape Vapes	**Brief Description:** Escape Vapes is a one-time or three-lesson series of prevention education. Youth participated in an educational presentation in-person and online that informed them about the safety risks and health risks of e-cigarette/vaping use. Through Escape Vapes programming that include PowerPoint presentations and integrated activities, youth will learn about nicotine and its effect on the brain. **Outputs/Impact Statements (Results):**	Family, Home, and 4-H and Youth Development (#6)

		The target audience was youth (n = 2,851) in 5th to 12th grades/ages 11-18. Of the students, 947 (38%) African American/Black,2% American Indian/Alaska Native, 1,751 (45%) White,4% Hispanic,.4% Native Hawaiian/Pacific Islander and 9% more than one race. Of the students, 1,432 (50%) male and 1,419 (46%) female. Of the students, 22% 5-6 grade, 53% 7-8 grade, 17% 9-10 grade and 8% 11-12 grade. Increased youth knowledge on how nicotine affects the brain. Before the program, 5% of youth stated they had no knowledge of how nicotine impacts the brain; 17% of youth had a "little" knowledge; 39% had some knowledge; and 39% had " a lot" of knowledge. After the program, only 1% of youth stated that they had no knowledge of how nicotine impacts the brain; 4% said "a little"; 15% said "some" and 79% said "a lot." Increased youth knowledge that vaping devices contain nicotine: Before the program, 4% of youth stated they had no knowledge that vaping devices contained nicotine; 9% said “a little”; 22% said they knew some; and 64% said they knew “a lot.” After the program, only 2% of youth stated they had no knowledge that vaping devices contained nicotine; 3% said “a little”; 13% said they knew some; and 81% said they knew “a lot.” Increased youth knowledge of the long-term effects of vaping: Before the program, 7% of youth had no knowledge concerning the long-term health risk of vaping; 19% had “a little”; 35% had “some”; and only 40% knew “a lot.” After the program, only 3% said they had no knowledge; 5% said “a little”; 22% said they had “some” knowledge; 70% said they now know the long-term health risk of vaping. Increased youth knowledge of how e-cigarette/vaping manufacturers target youth: Before the program, 6% of youth said they did not know about targeting; 18% said they knew “a little”; 30% said they knew “some”; and 46% said they knew “a lot” about targeting. After the program, only 2% said that they did not know about targeting; 7% said they knew “a little”; 16% said they knew “some”; and 75% said they now know “a lot” about targeting. Increased youth confidence to avoid nicotine products:	

		Before the program, 7% of youth did not have any confidence they could avoid nicotine products; 10% said they had “a little”; 20% said they had “some”; and 63% said they had “a lot” of confidence they could avoid nicotine products. After the program, only 3% said they did not have any confidence they could avoid nicotine products; 6% said they had “a little”; 14% said they had “some”; and 77% of youth said they were more confident in their ability to avoid nicotine products. Due to COVID-19, in-person programming, especially school-based youth programming, could not be implemented from April - December. Our team was able to implement programs in person Fall 2019 and Spring 2020 school year until schools closed. Some programming was conducted online, but since schools were working to just get the basics done, there was limited opportunities to do our programming.	
	AU Extension: Job Search Preparation	**Brief Description:** More Alabama families struggled economically in 2020 due to the COVID-19 pandemic. Over a half million Alabamians were laid off or furloughed from jobs. Job Search Preparation is a statewide career development project implemented by 8 Extension agent and 1 specialist of the Financial Resource Management and Workforce Development Team. The 3-lesson career prep curriculum focused on preparing adults to conduct a successful job search. Lessons on career choice, resume writing and interview skills were presented in a series, as individual lessons, face-to-face and online. **Outputs/Impact Statements (Results):** Agents conducted 93 activities and reached 636 participants. In response to the COVID-19 pandemic, program delivery transitioned to online methods, generating 73 activities. To enhance participant engagement and learning, the “Job Search Curriculum” was revised. Four online articles were published on the ACES website. Eighteen partnerships were established with public agencies and non-profit organizations. Of the 636 adults, 51%, were female and 49% were male. The program served 48% White, 49% Black, 2% Hispanic and 1% other races. Adults 30 years of age or older made up 58% of participants and young adults 19 to 29 years of age accounted for 42%.	Family, Home, and 4-H and Youth Development (#6)

		Participants significantly* gained an understanding of careers that match their personal characteristics. Pre/post results found participants' responses as 13%/0% as "poor"; 29%/5% as "fair"; 43%/33% as "good"; and 15%/62%* as "very good." Participants significantly* gained an understanding of using the computer to explore careers. Pre/post results found participants' responses as 17%/2% as "poor"; 23%/10% as "fair"; 41%/33% as "good"; 19%/55%* as "very good." Participants significantly* gained an understanding of guidelines for preparing an effective resume. Pre/post results found participants' responses as 17%/0% as "poor"; 39%/22% as "fair"; 32%/18% as "good"; 12%/60%* as "very good." Participants significantly* gained an understanding of how to prepare a cover letter. Pre/post results found participants' responses as 24%/3% as "poor"; 33%/22% as "fair"; 28%/10% as "good"; 15%/65%* as "very good." Participants significantly* gained an understanding of how to prepare an electronic resume. Pre/post results found participants' responses as 27%/3% as "poor"; 41%/18% as "fair"; 22%/19% as "good"; 10%/60%* as "very good." Participants significantly* gained an understanding of how to prepare to answer common interview questions. Pre/post results found participants' responses as 14%/0% as "poor"; 32%/8% as "fair"; 41%/36% as "good"; 13%/56%* as "very good." Participants significantly* gained an understanding of how to prepare questions to ask in an interview. Pre/post results found participants' responses as 14%/2% as "poor"; 34%/5% as "fair"; 37%/31% as "good"; 15%/62%* as "very good."	

		Participants significantly* gained an understanding of how to dress in a business-like manner for an interview. Pre/post results found participants' responses as 11%/2% as "poor"; 34%/3% as "fair"; 40%/30% as "good"; 15%/65%* as "very good."	
	AU Extension: Financial Well-Being for Adults	**Brief Description:** There is a need to support adults in adopting financial practices that foster family economic well-being. Too many Alabamians are financially fragile; unable to make ends meet, use credit excessively, save little or not at all, rely on high interest payday loans, manage their finances outside of secured financial institutions, and have no financial plan. Financial Well-Being for Adults is a statewide financial management program implemented by the Financial Resource Management and Workforce Development Team consisting of 8 Extension agents and 1 specialist. The program provided adults with the practical knowledge and resources to build the skills to manage their personal finances with confidence. The education was provided face-to-face and online. The topics included a spending plan, savings, banking, identity theft and credit. **Outputs/Impact Statements (Results):** The program targeted adults in Alabama but reached some teens and out-of-state participants. Instruction generated 1,254 total contacts, 98% adults, 2% teens, 96% in-state and 4% out-of-state. Alabama participants 60% female, 40% male; 53% Black, 45% White, 2% Hispanic and 1% other races. Significantly* more participants learned to develop a spending plan. Pre/post results found participants' responses as 25%/6% as "poor"; 23%/10% as "fair"; 35%/27% as "good"; 17%/57%* as "very good." Participants significantly* increased their ability to save for unexpected expenses and reduce financial stress. Pre/post results found participants' responses as 28%/2% as "poor"; 30%/8% as "fair"; 27%/40% as "good"; 15%/50%* as "very good." Significantly* more participants learned pros and cons of banking products. Pre/post results found participants' responses as 27%/10% as "poor"; 39%/13% as "fair"; 18%/34% as "good"; 16%/43%* as "very good." Participants significantly* increased their understanding of warning signs of identity theft and ways to reduce the risk of becoming a victim.	Family, Home, and 4-H and Youth Development (#6)

		Pre/post results found participants' responses as 16%/6% as "poor"; 33%/12% as "fair"; 34%/32% as "good"; 17%/50%* as "very good." Significantly* more participants learned how credit works and ways to reduce debt. Pre/post results found participants' responses as 28%/3% as "poor"; 39%/8% as "fair"; 24%/40% as "good"; 9%/49%* as "very good."	
	AU Extension: Skills to Pay the Bills	**Brief Description:** Soft skills are essential interpersonal skills that make it possible for youth/young adults to build relationships, overcome difficulties, adapt to change, and make meaningful contributions. 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. Skills to Pay the Bills is an activity-based program to help 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. Due to the COVID-19 pandemic, Skills to Pay the Bills programs were transitioned to online delivery methods resulting in 116 educational activities presented using Facebook, Zoom. **Outputs/Impact Statements (Results):** The target audience reached 1,844 traceable, in-school youth and 356 out of school young adults between 14 to 19 years of age; 55% female, 45% male; 38% Black, 58% White, 3% Hispanic and 1% other races. Participants significantly* gained the ability to demonstrate action to show positive team spirit (teamwork) as an important essential skill in the job market. Pre/post results found participants' responses as 4%/1% as "poor"; 11%/2% as "fair"; 42%/23% as "good"; 43%/74%* as "very good." Significantly* more participants rated their ability to recognize individual strengths and needs regarding teamwork.	Family, Home, and 4-H and Youth Development (#6)

		Pre/post results found participants' responses as 4%/2% as "poor"; 19%/6% as "fair"; 48%/23% as "good"; 29%/69* as "very good." Significantly* more participants gained an awareness of how non-verbal communication can be interpreted by others. Pre/post results found participants' responses as 5%/1% as "poor"; 25%/8% as "fair"; 46%/32% as "good"; 24%/59%* as "very good." Significantly* more participants gained an understanding of the value of being specific in communication. Pre/post results found participants' responses as 3%/1% as "poor"; 25%/6% as "fair"; 49%/28% as "good"; 23%/65%* as "very good." Significantly* more participants gained confidence in their ability to use two-way communication. Pre/post results found participants' responses as 14%/2% as "poor"; 33%/6% as "fair"; 34%/40% as "good"; 19%/52%* as "very good." Significantly* more participants gained an understanding that problem solving, and critical thinking is the ability to use knowledge, facts, and data to effectively solve problems. Pre/post results found participants' responses as 3%/1% as "poor"; 17%/5% as "fair"; 44%/24% as "good"; 36%/70%* as "very good." Significantly* more participants gained an understanding of their ability to examine different views to make decisions. Pre/post results found participants' responses as 5%/3% as "poor"; 23%/4% as "fair"; 47%/30% as "good"; 25%/63%* as "very good." Significantly* more participants gained an understanding of the need to show enthusiasm in a job interview. Pre/post results found participants' responses as 2%/1% as "poor"; 16%/4% as "fair"; 43%/24% as "good"; 39%/71%* as "very good." Significantly* more participants gained confidence in their ability to display a positive attitude.	

		Pre/post results found participants' responses as 46%/2% as "poor"; 24%/6% as "fair': 4%/31% as "good"; 26%/61%* as "very good."	
	AU Extension: Small Business Workshop	**Brief Description:** Small businesses need to understand how to manage risk, prevent lawsuits, manage finances, and understand federal and state taxes. Small business workshops are offered in 4, 2-hour segments. Business topics are: (1) Starting a Business from Scratch that covers selecting a product, licenses, and risk management. (2) Business Economics and Marketing that covers how to figure a profit margin, consumer economics, how to identify a market and employee issues. (3) Business Plans and How to Establish an Internet Site that covers creating a short- and long-term business plan using the AgPlan system and how to develop a business internet site. Participants set up their accounts on AgPlan's website and are offered direct help in developing their business plans. (4) Business Bookkeeping and Taxes that covers federal and state taxes, Sch. C bookkeeping and business requirements of the Affordable Care Act. **Outputs/Impact Statements (Results):** The target audience was 146 adults with outreach emphasis to minority students in both urban and rural counties. Ages were from 24-68 years old; 66% under 55. Students were 54% Black, 46% White, 72% Females and 28% Males. Eight students attended the workshop to gain information to use rural farmland more effectively. They had inherited the farmland and are using their plan to develop a business on the rural land to generate income from the land. Individuals gained knowledge in business management, finance, and taxation. Of the students: 100% Increased understanding of risk management. 100% Increased financial management of their businesses. 100% Increased understanding of required business licenses. 100% Improved understanding of how to identify the market for their small business. 88% Increased understanding of federal and state tax issues and requirements. 82% Indicated they would prepare a small business plan to focus and guide their business. 80% Increased understanding of how to write and develop a business plan.	Family, Home, and 4-H and Youth Development (#6)

		60% Will use the information to file for an LLC or Corporation. 30% Indicated they would be hiring employees to help develop and grow their business. After March 2020, the COVID-19 infection rates caused Alabama to reduce capacity in all businesses. This caused a sharp reduction in new business licenses and new business start-up.	
	AU Extension: Tuning in to Kids	**Brief Description:** This six-session series teaches parents and caregivers how to support healthy social emotional development. Parents are introduced to skills of emotion coaching and can practice throughout the program. Parents are taught skills to emotion coach (reflect) on children's anxiety, sadness, and anger. Emotions are normalized and insight is given into different styles or parenting and child temperament. This was the first year and launch of the Tuning into Kids program in Alabama. Programming was delivered by four Regional Agents and the Program Lead (Specialist). In addition, eight community partners also trained in Tuning in to Kids and delivered in home visiting or small group (online) settings. All facilitators have been supported in biweekly mentoring sessions. Four students were also trained and are now certified facilitators. In May the program was transitioned temporarily to an on-online delivery, a manual was developed, equipment was purchased, and facilitators were trained. **Outputs/Impact Statements (Results):** Overall, 72 sessions were offered, reaching, on average, 11 persons per session, for a total of 828 person contacts of 1-2 hours each. The target audience are parents and caregivers of children of any age. Participants included adults who are custodial parents or caregivers as well as those parenting at distance, childcare providers, and youth in anticipation of parenting. Attendees included 36% male, 65% female, 92% adult, 8% youth, 48% white, 51% black, other included 2% Hispanic and 1% more than one race and 1% other. Relationship status: Single-26, Committed-5, married-7, divorced-2. Education: 9% had a bachelor’s degree and 47% had a high school diploma; 23% had not finished high school. Employment: 40% percent of participants were not in paid work. Incomes	Family, Home, and 4-H and Youth Development (#6)

		ranged from low up to the $40,000 to $60,000 range, with most falling in the low to moderate income range. Participants learned emotional awareness and emotion coaching. The self-assessed on “knowledge of ways to manage stress” changed from a mean of 2.57/4.0 to 3.20/4.0 for 43 respondents. Repeated measures ANOVAs were conducted to test differences between two self-assessed time points (pre-intervention, post-intervention) as a within-subject variable. This enabled changes to be examined for all (within-subject analysis over time). Knowledge of ways to manage stress (F=37.098); and ways to manage anger (F=35.053) were significant at $p < .01$. Participants gained knowledge of child development. Repeated measures ANOVAs were conducted to test differences between two self-assessed time points (pre-intervention, post-intervention) as a within-subject variable. There was a significant increase in knowledge of child development (F=31.148), with a change in mean from 2.57 to 3.35. Participants gained knowledge and motivation to use family supportive resources. Repeated measures ANOVAs were conducted to test differences between two self-assessed time points (pre-intervention, post-intervention) as within-subject variable. This enabled changes to be examined for all (within-subject analysis over time). On “My knowledge of community resources” the final mean was 3.20/4.0 ($F=12.317$, $p < .001$). On “Commitment to using available social services that apply to me” the final mean was 3.14 ($F=21.012$, $p < .01$). Both measures indicate parents under stress are more likely to know about and seek support, an indicator of prevention of child maltreatment. Due to the COVID-19 pandemic evaluation was impacted as it was very difficult to deliver and collect forms. Most parents did not have strong enough broadband to complete on-line forms. Although our community partners were greatly affected, making parents more difficult to reach and serve, the need stayed high or became higher. As a result, we continued to serve and were gratified to have strong interest, especially as we had the scale to resolve technology challenges	

		and resource issues that many of our smaller community partners could not overcome.	
	AU Extension: Just in Time Parenting	**Brief Description:** Over 80% of new parents are under 30 years of age, and most are engaged in on-line information seeking, including parenting tips (Zero to Three National Parenting Report, 2009). Just in Time Parenting is a national project, hosted by Alabama Cooperative Extension, that offers 60 e-newsletters in Spanish or English with information about developmental milestones, tips for caregiving and nutrition and suggestions for family activities. The planned activity for 2020 was to increase distribution and awareness of JITP by engaging students and Regional Agents in marketing JITP. In 2020, we developed a bookmark, initiated the process of developing a new logo, improved the website and developed templates for statewide reports using three data sources. We convened a marketing team with the Regional Agents in Alabama and elsewhere in June, but progress was interrupted by the retirement of our Regional Agents in August and then the disbanding of the team in Sept. We also obtained a grant to study ways to return value-added evaluation to our state stakeholder partners. **https://jitp.info** **Outputs/Impact Statements (Results):** The planned audience are all parents and caregivers of young children in Alabama, including childcare professionals. A national survey of 1,002 parents (2016) demonstrated that 96% have access to online resources and 94% owned smartphones. These parents differentiate between credible, trusted sources with medical or other authoritative experts, versus commercial sites which are not as well trusted. Sixty-five percent indicate that they trust sites more when they include personal testimonials, and 41% of parents have gone online to connect with other parents, while 38% sign up for e-mail alerts, and 18% sign up for text alerts. In Alabama, the total number of children aged five and under in 2020 was 296,000, including eighteen counties with less than 1,000 children 5 and under, forty-two with between 1,000 and 10,000 children and seven metropolitan areas	Family, Home, and 4-H and Youth Development (#6)

		with more than 10,000 children. The total number of households with children is of course smaller than this. As of Dec. 31, 2020, there were 706 subscribers with active status in Alabama (including parents, childcare providers, and educators) and 532 unique website visitors. Readers developed change in parenting behavior with young children. Mean of "knew what to expect" at the age of the child (mean 3.33/5.0). parents of infants used the parenting tips to care of their baby (3.31/5.0). parents of two and three-year olds "used ideas about ways to play (mean 3.09/5.0). Readers developed increase in parenting confidence. Respondents to a national survey indicate that "after reading JITP, I feel more confident in my skills as a parent" (mean 3.11/5.0) and "feel less stressed" (3.07/5.0). Alabama survey respondents were similar to national respondents in education, income levels, and distribution of roles (professional educators vs. parents/caregivers), suggesting that the national results would hold for the Alabama subscribers. Readers developed protective factors against child maltreatment. Parents/caregivers of 2-3 years olds indicated that after reading the JITP newsletter, they: "Established routine for my child, such as for meals and bedtime" (mean 3.12/4, SD .66). Routines are key to enhancing stability and security for young children, and help young children learn to behave by giving them boundary expectations. In addition, parents of 2-3-year-olds "used ideas to get their children to behave" (mean 3.22/5.0; SD .60); and "used ideas to protect my child from accidents and injuries" (mean 3.06/5.0; SD .64). Parents/caregivers of one-year olds "Noticed babies cues more" (mean 3.22/5.0; SD .67). This indicates more responsiveness, which is protective against neglect. Google analytics: In 2020, there were 532 (505 new) individual users from 82 cities in Alabama. There were 706 subscribers, ranking Alabama 25th out of 50 states, compared to the total population.	

	AU Extension: 24/7 Dad	**Brief Description:** The purpose of 24/7 Dad is to increase parenting skills of fathers with children 18 years and younger. The target audience is all fathers with a special emphasis on underserved fathers such as rural, fathers with Head Start children, incarcerated and those returning home from prison. Fathers returning home from prison need assistance to reconnect with their children. They are also at-risk for decreased father involvement and higher rates of child abuse and neglect. 24/7 Dad seeks to increase the parental knowledge of pro-fathering factors. Underserved fathers participate in parenting classes focused on: 1) positive relationship skills 2) enhanced coparenting quality 3) dating abuse prevention skills 4) cooperation with child support enforcement (CSE) & commitment to pay child support 5) greater work and education commitment 6) greater use of support services 7) positive parenting skills 8) enhanced relationship quality with child and 9) enhanced child adjustment. **Outputs/Impact Statements (Results):** Twelve weekly sessions were conducted at a reentry center and YWCA. At the reentry center, 34 parents enrolled into 24/7 Dad; 12 fathers and 1 mother completed all 12 sessions at the reentry center. Only 11 parents were able to complete the program assessment due to COVID-19. At the YWCA, 14 parents enrolled into the fatherhood program; 9 mothers and 5 fathers were not able to complete the 12-sessions to COVID-19. Demographics: 1) median age 35; 7% 19-24 yr; 27% 25-30 yr; 39% 31-40 yr; 27% 40 yr. 2) 20% Female, 80% Male. 3) 62% White, 33% African American, 5% other; 5% Hispanic. 4) 49% Single, 7% Relationship, 28% Married, 12% Separated, 4% Divorced. 5) Work Status Pre-Program: 37% not working for pay, 40% working full-time, 23% working part-time.	Family, Home, and 4-H and Youth Development (#6)

		6) Education Level Pre-Program: 18% no high school, 53% high school degree/GED, 7% 2-year associate degree, 18% trade degree, 2% 4-year degree, 2% Master's degree. 7) Income Level Pre-Program: 62% income less than $10,000 yr, 33% earning $10,000-29,999, 5% earning $30,000^{+} Parents increased their knowledge of conflict management skills by 18%. Parents increased their knowledge of communication skills by 12%. Parents increased their knowledge of parent child relationship quality by 8%. Due to COVID-19, programming was halted. The reentry center and YWCA homeless shelter stopped all programs. Auburn University also suspended travel to any community sites.	
	AU Extension: Fathering in 15	**Brief Description:** The Fathering in 15 Online Tool was piloted. The retrospective pre-post survey was developed. The tool was launched to assist fathers with access to father-focused parenting education. Each module can be completed in 15 minutes and covers the following 15 topics: 1) Family History 2) Being a Man and Dad 3) Handling Emotions 4) Grief and Loss 5) Your Health, You and Mom 6) Talking with Mom 7) Co-Parenting 8) Fathering Skills 9) Child Development 10) Child Discipline 11) Sexuality 12) Intimacy 13) Work-Family Balance 14) Managing Money. **Outputs/Impact Statements (Results):**	Family, Home, and 4-H and Youth Development (#6)

		The target audience was fathers who were at-risk of negative-fathering behaviors and child interactions. The tool can be used with all fathers regardless of demographics such as ethnicity, religion, and SES. The number of parents who completed the evaluation was 11: 55% White, 18% Black, 18% Hispanic and 9% other; 27% employed full-time, 18% received disability, 36% unemployed. Participants' education ranged from middle school to graduate school. Several agencies from Alabama referred fathers to Fathering in 15. One agency in California referred fathers. 11 parents completed the retrospective pre-post evaluation and received a certificate of completion. Participants' knowledge gain is listed below between their post/pre-test scores: Parents increased their knowledge of effects of coparenting on child 54%. Parents increased their knowledge of family history impact on parenting by 52%. Parents increased their knowledge of what positive parenting involves by 49%. Parents increased their knowledge of commitment to ideal fathering images by 42%. Parents increased their knowledge of seeking parenting support by 42%. Parents increased their knowledge of appropriate types of discipline by 40%. Parents increased their knowledge of being involved in child's education by 35%. Parents increased their knowledge child development and ages by 24%.	
	AU Research: Advancing Military Family Science Through Research and Outreach	**Brief Description:** Military family research What has been done? This research concerns three critical issues in Alabama: 1) employment opportunities and circumstances that influence decisions to enlist in the military, 2) the well-being of youth in military-connected families, and 3) 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. A digital repository of military family research has been created, containing 3,021	Family, Home, and 4-H and Youth Development (#6)

		holdings (e.g., research articles, research summaries, action-based reports) that are free and easily accessible to stakeholders. **Outputs/Impact Statements (Results):** Almost 315 people have requested and received a monthly newsletter with research-based applications for military families, and over 1000 people follow the project content on social media. Organizations and agencies increasingly request project resources to inform their decision making. Data analyses to date reveal that service members and spouses who reported higher levels of marital warmth also reported better mental health. Additional data analyses and dissemination of military family research resources are underway. Target Audience: Scientists, students, policymakers, health professionals, and general public	
	AU Research: Risk and Protection in the Context of Peer Stress: Child and Parent Responses	**Brief Description:** Responses to peer victimization in early adolescence Data collection has included self-reported and observational measures of parent and adolescent responses to peer stress, as well as autonomic physiological measures of adolescents' responses to peer stress. **Outputs/Impact Statements (Results):** Peer victimization experiences predicted sleep problems in early adolescence. Seeking revenge and support in response to peer victimization predicted peer problems across the transition to middle school. Additional data analyses are underway. Target Audience: Scientists, students, policymakers, health professionals, and general public	Family, Home, and 4-H and Youth Development (#6)
	AU Research: Using Deviance Regulation Theory to Combat Bullying	**Brief Description:** Effective strategies to reduce bullying and create supportive, safe school environments. A novel intervention activity based on Deviance Regulation Theory (DRT), designed to increase defending behaviors (i.e., supporting children who are bullied), has been delivered in fourth- and fifth-grade classrooms. Data collection has included teacher reports as well as self and peer reports from over 1,500 students across 13 elementary schools.	Family, Home, and 4-H and Youth Development (#6)

		Outputs/Impact Statements (Results): A newsletter with empirically based information about child development has been delivered to parents of children in participating schools. Analyses of the effects of the DRT intervention are underway. Preliminary analyses suggest increases in teacher-reported (but not self- or peer-reported) defending in the DRT intervention group compared to the control group. Target Audience: Scientists, students, policymakers, health professionals, and general public	
	Tuskegee Extension: Addressing needs of youth at risk	**Brief Description:** 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. **Outputs/Impact Statements (Results):** 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. Results indicated that of the 345 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 84% reported increases in their ability to apply science (includes agriculture, engineering, design, culinary arts, etc.). Participation in the program decreased substantially from FY2019 due to the pandemic.	Family, Home, and 4-H and Youth Development (#6)

	AU Research: Development of new wood composites for packaging applications	**Brief Description:** Most of the adhesives that are used in forest product industry are derived from petroleum based. The proposed research will investigate the use of agriculture-based products such as soybean flour or lignin as a replacement of petroleum derived adhesives. The team met with three wood product companies and assessed their needs. The team explored the possibility of making a lighter and cheaper oriented strand board (OSB) through the addition of lignin-retained cellulose nanofibers (LCNF). A factorial design was deployed to understand the effect of resin amount, density, and nanocellulose amount would have on strength, moisture resistance, and internal bond. **Outputs/Impact Statements (Results):** The models developed by the team showed that a maximum density reduction of 0.05 g/cm^3 might be possible if the cost of LCNF (solid basis) is equivalent to polymeric diphenylmethane diisocyanate (1:1 ratio); conversely, it was determined that LCNF was not cost effective if it was 7 times more expensive than pMDI (7:1 ratio). A new products patent application was submitted utilizing soy for wood composites. The allowed claims are directed to methods of preparing pressed wood composites where the synthetic resin comprises diphenylmethane diisocyanate (MDI). Target Audience: Scientists, students, forest products industry, and general public.	Sustainable Energy (# 7)
	AU Research: Nanocellulose-based materials for novel applications	**Brief Description:** Use of nanocellulose in adhesives production and water treatment is still lacking, and its effects on those applications are not fully understood. Nanocellulose has been produced and characterized from different biomass including soybean hulls. They have been tested for microsystin adsorption to be used in water remediation and also for wood composites manufacturing to obtain higher strength. The team studied the effect of the chemical composition of soybean hulls and wood fibers on the rheological behavior of bleached and unbleached nanocellulose suspensions produced therefore through steady-state and oscillation tests. Also, the team studied the interfacial interactions between a common wood composite adhesive such as urea formaldehyde with bleached (BCNF) and lignin containing (LCNF) cellulose nanofibrils.	Sustainable Energy (#7)

		Outputs/Impact Statements (Results): Most of the results are being finalized for the manuscripts but the team published six peer-reviewed manuscripts. Target Audience: Scientists, students, forest products industry, and general public	
	AU Research: Integration of anaerobic digestion with algae cultivation for conversion of agricultural wastes to bioenergy, clean water, and animal feed	**Brief Description:** Constant use of poultry litter as a fertilizer in agriculture fields has overloaded those field with phosphorus. The proposed research will investigate an alternative approach to poultry litter management that will lead to reduced environmental impacts and greater income for farmers. Researchers focused on biological treatments of poultry litter and their impacts on phosphorus solubilization. The group investigated the impacts of moisture content and the presence/absence of updraft aeration on biochemical phosphorus solubilization. The group also tried to grow algae on anaerobic digestate that is rich in nutrients, especially nitrogen and phosphorus, which are major nutrient pollutants if released directly into the environment. Additionally, the team investigated feeding wastewater-grown algae to the zooplankton Daphnia pulicaria. Daphnia and related zooplankton are an existing fish feed source. **Outputs/Impact Statements (Results):** The results showed that the high-moisture anaerobic conditions led to the highest amount of water and bicarbonate-extractable (i.e., labile) phosphate. The implication is that anaerobic digestion of litter may be a potential tool to extract phosphorus prior to litter application whereas composting may actually have a stabilizing effect on P leachability. Past efforts to grow algae directly on anaerobic digestate have generally not been successful due to the high concentration of inhibitory molecules in digestate. The team employed aerobic pretreatment process to overcome algal growth inhibition on anaerobic digestate. The team found out that in addition to monocultures of Chlorella, the native algal polyculture also supports Daphnia growth. This is encouraging because native polycultures are the only way this system will be able to operate cost-effectively in an agricultural setting. Target Audience: Scientists, students, poultry farmers, high school students, water utilities and general public.	Sustainable Energy (#7)

	AU Research: Development of AI-powered robotic high-throughput plant phenotyping systems for precision peanut breeding and forest tree seedling inventory in Alabama	**Brief Description:** Plant phenotyping is the quantitative assessment of complex plant traits such as health, productivity, architecture, growth, and yield. Traditional plant phenotyping mainly relies on human efforts, which is labor-intensive, time-consuming, error-prone, and ergonomically poor for field workers. A UAV-based multi-modal crop imaging platform and a ground-based pine seedling imaging platform were being developed. **Outputs/Impact Statements (Results):** The project just started and there are no significant results to report. Target Audience: Peanut growers, Forest Landowners, Agriculture Industry, and general public.	Sustainable Energy (#7)
	AU Research: Bioenergy and bioproducts production through systematic metabolic engineering and bioprocess engineering of solventogenic clostridia	**Brief Description:** 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. The group focused on (1) enhancing carbon source metabolism in solventogenic clostridia through metabolic engineering approaches to improve utilization of carbon sources, (2) Evaluating lignocellulosic hydrolysates as the feedstock for biochemical production using engineered solventogenic clostridia. **Outputs/Impact Statements (Results):** The team overexpressed efflux pump genes from P. putida to enhance tolerance of hyper-butanolproducing Clostridium saccharoperbutylacetonicum to fermentation inhibitors. Interestingly, overexpression of the whole unit resulted in decreased tolerance, while overexpression of the subunit (srpB) alone exerted significant enhanced robustness of the strain. Compared to the control, the engineered strain had enhanced capability to grow in media containing 17% more furfural or 50% more ferulic acid and produced ~14 g/L butanol (comparable to fermentation under regular conditions without inhibitors). With glucose as sole carbon source, the synthetic consortium was able to produce 18.1 g/L butanol, with a productivity of 0.50 g/L·h, which was 40.4% higher than that by the monoculture.	Sustainable Energy (#7)

		When mixture of glucose and xylose was used as carbon source at a ratio of 1:1 (w/w), the co-culture could consume xylose more efficiently, and led to 47.2% more butanol production and a 29.4% higher yield than the monoculture. Finally, when the co-culture system was employed to produce butanol from hydrolysates derived from corncob, a high butanol titer of 18.0 g/L was achieved under batch fermentation. Target Audience: Scientists, students, Biotech companies, and general public.	
	AU Research: Biomass conversion into biofuels and high-value products	**Brief Description:** 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. The group has worked on converting biomass that includes forest and agricultural residues and oilseed crops into biofuels and bioproducts. The team converted municipal sludge into biofuels, produced diesel and jet fuels from Carinata (non-food crop oilseeds), produced filaments from polylactic acid and lignin and used biochar for enhancing methane production. **Outputs/Impact Statements (Results):** With municipal sludge, the highest oil yield of 37.7±1.6 wt.% (dry basis, ash-free) was obtained in the thickened sludge liquefied at 325ºC, while the highest char yield of 20.6±1.6 wt.% was obtained in the catalyzed secondary sludge liquefaction at 325ºC. The higher heating value of the produced biocrude ranged from 24-35 MJ/kg. In terms of Carinata oil research, the highest liquid yield of 81% with HHV of 47 MJ/kg was obtained using nickel on alumina 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 profile. Reaction pathways were proposed according to the chemical analysis of the products. Further, we evaluated the effect of lignin in polylactic acid, and the two plasticizers (ploy ethylene glycol-PEG), and struktol in PLA_L20 (20% lignin) composites was investigated via tensile test, differential scanning calorimetry, thermogravimetric analysis, scanning electron microscopy, Fourier transform infrared spectroscopy of the filaments, and dynamic mechanical analysis of 3D printed samples. A 2 wt% PEG was able to enhance	Sustainable Energy (#7)

		both tensile stress and elongation at maximum load of PLA_L20 composite by 19% and 35%, respectively, whereas struktol TR451 was able to improve elongation at maximum load by 24%. Our biochar study showed that the biochar significantly enhances methane (CH_4) production rate and increases its final yield during anaerobic digestion. The cumulative highest CH4 production obtaining in cultures with DF500 (biochar from Douglas fir at 500 °C) was about 11% and 98% more than the culture without biochar at 37 °C and 25 °C AD temperature, respectively. At 55 °C, the maximum CH_4 yield reached 172.3 ml/g COD with DF730, which was about 48.3% more than the control culture. Target Audience: Scientists, students, policymakers, and farmers.	
	Tuskegee Research: Plant-derived biopolymers an alternative to synthetic polymers	**Brief Description:** Plant-derived biopolymers are renewable and readily available, thus making viable alternatives to synthetic polymers. **Outputs/Impact Statements (Results):** The present study examined properties of biopolymers from cover crops such as rye, oat, clover, vetch, and barley, which were grown organically in a greenhouse. The yields of cellulose, hemicellulose, and lignin of the cover crops were calculated based on the dry weight. Structural variations and thermal properties of the isolated cellulose were characterized and compared with commercial cellulose using Fourier transform infrared (FTIR) spectroscopy, Raman spectroscopy, and Thermogravimetric analysis (TGA). The average yield percentages of cellulose, hemicellulose, and lignin were 19 to 27%, 9 to 25%, and 1.42 to 4.86%, respectively. The FTIR and Raman spectral analysis indicated that the isolated cellulose had similar peaks and patterns to commercial cellulose and confirmed the removal of non-cellulosic constituents. The onset decomposition temperature occurred at 270 °C in all samples. Interestingly, the maximum degradation temperature beyond 370 °C in cellulose was isolated from black oat, which was higher than commercial cellulose (350 °C). The findings of this research suggest that cellulose isolated from cover crops may be a benefit to the polymer industry in the development of bio-based materials such as biofuels, bio-composites, and biomedical devices.	Sustainable Energy (#7)