Texas (Texas A&M University) Annual Report - FY2021

Report Status: Approved as of 07/08/2022

Contributing Organizations

Texas A&M University

Executive Summary

Overview

Critical Issue: Environmental Management (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Adult and Community Leadership (1862)

AgriLife Research: A total of 3 projects were submitted under this critical issue covering topics such as cognitive influence & critical thinking. 2 of the 3 reports were highlighted in the Annual Report of Accomplishments. One of the highlighted projects led by Dr. Kim Dooley focuses on impact evaluation for evidence-based decision making. Another project led by Dr. Barry Boyd evaluated the QUEEN Critical Thinking Model and QUEEN Student Self-Assessment tool. Both tools have allowed instructors to demonstrate the impact of teaching for critical thinking and measure student growth in critical thinking behaviors. Students in an upper-level applied ethics course (N=302) demonstrated significant growth in critical thinking behaviors over the course of one semester. The QUEEN assessment tool is being expanded for use at the University of Florida and other departments at Texas A&M University.

Critical Issue: Agriculture Production (1862)

AgriLife Research: A total of 76 project reports were submitted under this critical issue covering various agriculture related topics including plant breeding and genomics, cropping systems, horticulture, pest and disease management, and livestock production and genetics. 19 of the 76 reports were highlighted in the Annual Report of Accomplishments. Selected projects and impact statements:

Corn and cotton breeding: A project led by Dr. Hongbin Zhang has resulted in the cloning of most genes controlling corn grain yield and quality traits and cotton fiber yield and quality traits and developed gene-based breeding in corn and cotton the largest and fourth largest crops in the United States. Studies have shown that gene-based breeding can potentially further improve current best varieties by up to 118%, markedly improving agricultural productivity and increasing farmers' incomes. Based on current values of both crops, the U.S. corn and cotton farmers' annual incomes will increase by $6.1 billion and $0.56 billion, respectively, if the new breeding technology is used to improve their varieties by 10%.

Peanut production: In Texas, peanut producers continually face issues of pests, diseases, and drought. For example, root-knot nematode damage can cause losses up to 90%. However, resistance from wild relatives imparts almost total immunity with no treatment required which represents a $48,000,000 annually savings for US growers as well as the added benefit the helping the environment. A project led by Dr. John Cason developed the first root knot nematode resistant variety and continues to improve and release new higher yielding ones today. Similarly, the program continues to develop Sclerotinia minor resistant varieties, that can save producers up to $150/ac/year in fungicide applications.

Genetic engineering of cottonseed as food for humans or animal feed: In a project led by Dr. Keerti Rathore, cotton was engineered to selectively eliminate toxic gossypol from the seed without altering the levels of this protective chemical in rest of the plant, thus retaining the plant's defensive capabilities. Indirectly, it can be used as feed for poultry and aquaculture species that are highly efficient in converting feed protein into edible animal protein. Its global adoption has the potential to significantly improve nutrition security and boost farmers' income without requiring additional input or acreage under cultivation.

Texas is the second largest state in the nation with approximately 29 million citizens. The size and scope of Texas pose unique challenges with a wide range of diversity including both the agricultural and human sectors. The issues and needs of Texans vary by numerous factors and, in many cases, are complex. Texas is one of the most rural and most urban states in the nation with a majority of its citizens living in 20 of the 254 counties in the state.

AgriLife Extension and AgriLife Research

Texas A&M AgriLife Research (AgriLife Research; formerly Texas Agricultural Experiment Station) and the Texas A&M AgriLife Extension Service (AgriLife Extension) are the land-grant research and Extension components of the Texas A&M System and are headquartered in College Station, Texas. Since its beginning in 1876 as a land-grant institution, Texas A&M University has been a recognized leader in agriculture, food, and natural resources. Today, Texas A&M University, AgriLife Research, and AgriLife Extension continue this legacy through outstanding academic programs, important contributions to science through research and discovery, and life-long learning and youth development through Extension programs.

The work of both AgriLife Research and AgriLife Extension is guided by strategic plans. AgriLife Research developed a strategic plan to focus its resources on issues of highest importance as identified by agency scientists and other stakeholders. The major topical areas in the strategic plan are identified as priorities. These priorities are vital and equally important to ensuring a positive future for Texas and its citizens. The priorities are as follows:

1) Achieve resilience in food, fiber, and ecological systems through adaptive strategies.

2) Detect, monitor, and mitigate insect vector-borne diseases and invasive species.

3) Enhance agricultural information systems and expand their use through innovative applications.

4) Integrate basic and applied research at the nexus of food and health.

AgriLife Extension developed a strategic plan to help communities engage, learn and flourish in the face of declining personnel, population changes and technology changes. In order to serve Texans for decades to come the plan focuses on how we do business to maximize effectiveness. The foundation of the plan focuses on five key themes:

1) Invest in appropriate technologies and train people to use those tehcnologies skillfully.

2) Develop a program strategy that both ensures coordinated, integrated programs to serve Texans and that coordiante how we evaluate and promote those programs.

3) Retain and recruit outstanding people acorss AgriLife Extension.

4) Pursue operational efficiences

5) Ensure effective internal communications

Work on issues of importance in the state is a joint endeavor by both AgriLife Research and AgriLife Extension. Research-based information is translated to practical best management practices and disseminated via multiple channels including the network of agents in all 254 counties in the state.

Both AgriLife Research and AgriLife Extension conduct identification of issues and needs at multiple levels. Grassroots involvement by citizens, advisory groups, and commodity and industry groups are just a few of the ways this information is generated. Work with other states on areas of shared interest is also of high priority. This report addresses programs of primary importance in Texas. The programs selected also address federal initiatives for agriculture and natural resources, individuals and families, communities, and youth and adult leadership development.

Cropping systems and carbon sequestration: The results of a project led by Dr. Katie Lewis have demonstrated a greater potential to sequester carbon in irrigated cropping systems producing greater biomass in heavier textured soils. In a harsher environment (sandy soil and deficit irrigation), research has demonstrated the potential to sequester on average 0.14 ton carbon/acre annually to a 36 inch depth when using no-tillage and a rye cover crop following cotton harvest. At this rate of carbon accumulation, there is the potential for

irrigated cotton cropping systems using no-tillage and a winter rye or wheat cover crop to sequester approximately 230,000 ton carbon annually across the Texas High Plains. Our stakeholders are using this information when making decisions on conservation management practices aimed at carbon programs. Through increased carbon storage and subsequently improved soil health, there should be less wind erosion of soil which will positively impact the broader public.

Plant disease management: Fastidious (or unculturable) pathogens cause devastating plant diseases such as citrus greening, potato zebra chip, and pierce's disease of grapes. A technology (microbial hairy root system) was developed by Dr. Kranthi Mandadi's program which enabled four to six times faster efficacy screening of potential therapies. The technology is being utilized by >10 public and private-sector stakeholders to speed the discovery of new therapeutics effective against unculturable pathogens. Commercialization of one or more of these therapies could result in saving the US $3 billion or more in annual economic losses caused by unculturable plant pathogens.

Animal production. A project led by Dr. George Perry has investigated the role of a mild stress during pregnancy on embryo development and transgenerational impacts. Prenatal stress did not impact the ovarian reserve in female offspring. Among male offspring no difference has been detected in performance, but semen produced by males stressed in utero had reduced ability for early embryo development, indicating these embryos are more likely to die. Thus, stressful events during pregnancy may not impact the current breeding season but may impact pregnancy success for years to come. Thus, changes in current management practices can result in an improvement in embryonic survival by as little as 10% from 50% to 60% it would increase the number of beef cows pregnant early in the breeding season in the United States by 3.12 million head (31.2 million beef cows x 0.10 = 3.12 million). This would translate into an economic impact of roughly $1.45 billion (31 lbs/cow x 31.2 million cows = 967,200,000 lbs x $1.50/lb = $1,450,800,000 million).

AgriLife Extension programs focus on research-based production and management practices, evaluation of technologies, improved decision-making, water-use efficiency & job training. Extension is at the forefront in responding to emerging issues such as drought, wildfires, and insect and disease outbreaks. **Crop production** programs cover variety testing, irrigation efficiency, disease, pest management & control, commodity marketing, financial risk management & farm bill education. **Livestock production** programs focus on improved reproduction strategies, animal health, feeds and nutrition, forage production, breeding stock replacement strategies and livestock marketing. Through **16,700 educational events**, AgriLife Extension achieved more than **2.1 million** educational and other contacts. Livestock and dairy production programs resulted in an estimated economic gain of **$84.5 million**, and crop and livestock-related financial risk management programs resulted in estimated gains of **$26.9 million**. Outreach related to crops, floriculture and nursery production led to an estimated increase in annual net returns of **$54.9 million** and assisted cotton growers with variety selection valued at **$26.2 million**. The **boll weevil eradication** program had estimated benefits of **$350 million**, with cumulative benefits of **$5.1 billion** since 1996. These crop and livestock-related impacts supported an additional **4,018 jobs** in agribusiness and retail sectors. **33,816 Texas farm units** were analyzed using the web-based decision aid for the 2018 Farm Bill, developed by the Agricultural and Food Policy Center (AFPC), with an estimated impact of improved decision-making valued at **$79.7 million**. Provided required job training and continuing education for 62,635 business owners and employees, with an annual wage base of **$1 billion**.

Through **5,400 educational events**, more than **730,000** educational and other contacts**.** The economic benefit resulting from the increase in net returns for boll weevil eradication was estimated at **$350 million**, with cumulative benefits surpassing **$5.1 billion** (since 1996). Outreach related to crops, floriculture, nursery production and marketing led to an estimated increase in annual net returns of **$54.9 million**, and assisted cotton growers with variety selection valued at **$26.2 million**. The impacts above support an additional **4,018 jobs** in agribusiness and retail-related sectors. **33,816 Texas farm units** were analyzed using the web-based 2018 Farm Bill Decision Aid, developed by the Agricultural and Food Policy Center (AFPC). The estimated impact of improved decision-making was **$79.7 million**. Through continuing education related to pesticide safety and cotton ginning, job training supports 62,319 Texas jobs, with an annual wage base of **$1 billion**. Programs for livestock operations focus on improved reproduction strategies, animal health, feeds and nutrition, forage production, breeding-stock replacement strategies, livestock marketing and financial risk management. Through **11,200** educational events, planning meetings and workshops, **reached more than 1.4 million** educational and other contacts. The increase in net returns resulting from the adoption and implementation of selected beef cattle management practices resulted in a total economic benefit of **$71.1 million**. For dairy operations, the economic benefits resulting from the adoption of heat abatement and other management strategies were estimated at **$5.3 million**. Extension programs focusing on managing livestock and crop financial risk led to estimated gains of **$26.9 million**.

Critical Issue: Community and Economic Development (1862)

AgriLife Research: A total of 7 project reports were submitted under this critical issue. 3 of the 7 reports were highlighted in the Annual Report of Accomplishments. One of the highlighted projects (led by Dr. Oral Capps) focuses on consumer demand analysis for food and beverage products. One study supported by the Cotton Board was conducted to evaluate the economic effectiveness of the cotton

checkoff program. The study concluded that the cotton checkoff program enhanced cotton and cottonseed demand, augmented U.S. cotton yields and production as well as cottonseed prices, generated a positive return to both cotton producers and importers, reduced the dependence of cotton producers on government farm programs, and benefited taxpayers. In particular, the study noted that over the period 1986/87 to 2019/20, the cotton checkoff program returned $6.40 per dollar invested in cotton promotion and accounted for 8.8% of the net revenue earned by cotton producers. The cotton checkoff program also returned $17.40 in after-tax profit per dollar of investment to retail cotton fiber importers and accounted for 11.2% of U.S. retail cotton product revenue since 1992/93.

AgriLife Extension: The Texas A&M AgriLife Extension Service offers numerous educational programs recognized by state and industry accreditation authorities for meeting continuing education and certification requirements. These programs serve thousands of people who render vital community services, enabling them to obtain or keep a job, start a business or stay in business.

AgriLife Extension directly supports **76,900 jobs** in Texas, with an estimated annual wage base of **$1.5 billion** with its workforce-related continuing education and certification programs.

- AgriLife Extension's **Child Care Conferences** directly support 300 child care businesses and 1,204 jobs, representing estimated annual revenues of **$176 million** and an annual wage base of **$28.1 million**.
- The federally designated **Pesticide Safety Education Program** in Texas directly supports 62,319 pesticide applicators in Texas, with a salary and time value of **$1 billion**.
- The **School of Irrigation** directly supports over 1,580 jobs in the landscape irrigation industry, with an estimated annual wage base of **$49.5 million.**
- The **Tax Practitioner Workshops** directly support 1,503 jobs, with an estimated annual wage base of **$118 million** by delivering continuing education to tax practitioners.

With the magnitude of Hurricane Harvey and the subsequent creation of the Governor's Commission to Rebuild Texas, the AgriLife Extension Service assumed a new, larger role in emergency response and recovery in support of the Texas Division of Emergency Management (TDEM).

AgriLife Extension has established six regional Disaster Assistance Response Teams (DART) to provide support for local communities to prepare for, respond to, recover from and become more resilient to all types of disasters. Works with agencies and organizations across the state in both education and response to help communities prepare long-term plans for land use, natural resources, and mitigation to reduce the impacts of disasters. For elected officials, planners and the public, AgriLife Extension personnel teach workshops on disaster preparedness, stormwater management, risk mitigation, federal reimbursement, sheltering people and animals, personal evacuation procedures, post-storm home safety and debris removal, and temporary housing, among other topics. Establishes and manages points of supply for animal shelters, assesses losses from damage, co-hosts recovery workshops with state and federal agencies, and conducts mental health first aid trainings. Since 2020, more than 200 AgriLife Extension agents and specialists have played integral roles in supporting statewide COVID-19 relief efforts.

-AgriLife Extension agents delivered more than 1 million COVID-19 vaccines to medical facilities, correctional facilities, and regional staging areas for further distribution. These vaccines are estimated to have resulted in 6,500 fewer hospitalizations and $75 million in reduced hospitalization costs.

-Supported and delivered 3.57 million COVID-19 test kits to school districts, nursing homes, city and county governments, chambers of commerce, universities, and youth summer camps; including employees at 18 food processing facilities with the goal of avoiding a COVID-19-related shutdown that would have placed more pressure on an already stressed food supply chain.

-Assisted with conducting 71,500 COVID-19 tests at the Texas State Capital and other venues by request, and delivered 105,000 vaccination records to the TDEM.

-Delivered 8,700 COVID-19 test kits and PPE to high-risk individuals at long-term care facilities, nursing homes, and medical offices; 44,000 cases of PPE and cleaning supplies to various other destinations, and 2,200 doses of therapeutic drugs to medical facilities.

-Developed on-line CARES Act education and training program targeting local government, agricultural producers, and school districts in all 254 Texas counties.

-Developed and delivered 343,982 online courses focusing on COVID-19-related child care issues to 200,000 child care providers.

Critical Issue: Community and Economic Development (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Connecting Agriculture and Health (1862)

AgriLife Research: A total of 6 project reports were submitted under this critical issue. 2 of the 6 reports were highlighted in the Annual Report of Accomplishments. The results of one project led by Dr. Elena Castell-Perez suggest that implementation of biodegradable antimicrobial packaging can reduce the risk of foodborne disease outbreaks due to the consumption of contaminated fresh produce and help reduce produce waste due to recalls. The Farm Fresh Foods for Healthy Kids project led by Dr. Rebecca Seguin-Fowler demonstrated significant improvements in dietary skills and intake (e.g., increase of 1/3 cup daily of fruits and vegetables) among low-income caregivers with children as well as improvement in household food security.

AgriLife Extension: Texas A&M AgriLife Extension has developed a response to the questions consumers are asking titled Path to the Plate. Path to the Plate is a comprehensive, educational approach to providing relevant, current, and factual information to consumers. Our goal is to educate consumers so they can make informed decisions when it comes to agriculture and their health.

Path to the Plate is an unbiased examination of agriculture, the food we eat, and the connection to our health. The program is designed to deliver correct, research-based information via a variety of methods.

The overarching goal of the Path to the Plate program is for all Texans to make informed decisions based on truthful and accurate information. More specific objectives of the program include:

- To work with organizations, agencies, communities and individuals to provide Texans with a wealth of information and perspectives so they may make better informed decisions about the food they eat.
- To present the important role of agriculture in our daily lives – from production to harvest to how it arrives at your table.
- To deliver correct, research-based information in order to educate the consumer in regard to agriculture and health.

Critical Issue: Crop Production and Utilization (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Disaster Management & Outreach (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Food Safety and Education (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Food Security in Texas Communities (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Fostering Strong Families (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Health and Wellness (1862)

AgriLife Research: A total of 9 project reports were submitted under this critical issue. One project project led by Dr. Yuxiang Sun was highlighted in the Annual Report of Accomplishments. The project focuses on improving the healthspan of aging adults through diet and physical activity. The results showed that Growth Hormone Secretagogue Receptor is an important regulator of macrophages and has a major role in inflamm-aging. The findings suggest that suppressing Growth Hormone Secretagogue Receptor in macrophages may provide an exciting new strategy to combat inflamm-aging and age-associated diseases, thus increasing healthspan.

AgriLife Extension: The Texas A&M AgriLife Extension Service delivers various educational programs focusing on health, wellness, and disease prevention for adults and youth, including diabetes education, nutrition and exercise, food safety, child safety seat education and early cancer detection.

The economic impact of eight AgriLife Extension health and wellness programs was measured in terms of lifetime health care cost savings, avoidance of lost wages, and nutrition-related food cost savings. These programs delivered **40,100 educational events** in 2021, resulting in more than **1.4 million** adult educational and other contacts, with economic benefits estimated at **$76.1 million. Highlighted programs include:**

- **Diabetes education programs** reached more than **92,000** educational and other contacts, teaching participants the skills to better manage their diabetes, and to effectively reduce the risk of developing diabetes . Lifetime economic benefits have been estimated at **$6.5 million**.
- **Nutrition and food resource management programs** reached more than **3,700 participants**, with economic benefits estimated at **$1.4 million.**
- **Physical activity** programs attracted **13,100 participants**, with lifetime economic benefits estimated at **$64.6 million**.
- **Child safety seat programs** save lives. The economic benefit of the proper use of child safety seats for the **1,900 participants** is estimated at **$3.6 million**.
- The **Healthy South Texas** program engaged more than **13,400 adults** and youths in healthy lifestyle education programs, with lifetime economic benefits estimated at **$9.0 million**. AgriLife Extension and the Texas A&M Health Science Center are working to reduce the highest-impact diseases and their consequences throughout a 27-county region in South Texas. The goal is to focus on prevention by engaging families and communities, promoting healthy behaviors, encouraging preventive care and improving disease outcomes.

Critical Issue: Healthy Lifestyles (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Natural Resources and the Environment (1862)

AgriLife Research: A total of 22 project reports were submitted under this critical issue. 5 of the 22 reports were highlighted in the Annual Report of Accomplishments. Two of the selected projects and impact statements are highlighted below.

Biological carbon sequestration in ecosystems: A project led by Dr. Asko Noormets has developed a conceptual model to estimate belowground carbon allocation in plants, and the efficiency of biomass production using commonly used but rarely co-deployed measurements of ecosystem carbon fluxes. It also allows the estimation of otherwise unmeasurable carbon fluxes like non-structural or storage carbohydrates, exudation and allocation to rhizosymbionts. To date, this model has been successfully tested on a chronosequence of loblolly pine production forests, and it captures age-related differences in carbon allocation to aboveground growth, belowground growth, and storage carbohydrates, contrasting respiratory costs of biomass production and different drought thresholds. Biological carbon sequestration can be effectively deployed as a climate mitigation tool only when carbon allocation to different tissues, carbon input pathways to soil and their decomposition pathways are quantitatively understood. This carbon allocation model provides a powerful and unique assessment tool for one of the major global challenges of this century.

Invasive species management: A project led by Dr. Jeff Brady investigated management of KR bluestem, an invasive grass from China that is taking over roadsides and grasslands throughout the southern portion of the U.S. It spreads widely and rapidly from seeds, crowding out native plants. The resulting KR bluestem monocultures support very few native species, leading to declines in insects, birds, and mammals. Prolific seed production limits control by herbicides, burning, disking, and grazing. Costs for restoring native grassland exceed $150 per acre and often result in a return to KR bluestem monoculture within 1 year. Dr. Brady's Laboratory has isolated microbes from the native plant little bluestem that perform biocontrol functions, inhibiting germination and growth of KR bluestem seeds. When combined with conventional control treatments, microbial biocontrol may provide the first sustainable large-scale restoration tactic for grasslands degraded by KR bluestem.

AgriLife Extension: The Texas A&M AgriLife Extension Service delivers a wide range of researched-based educational resources and programs on water quality, water-use efficiency, wildlife and fisheries practices, ecosystem and parks management, tourism and open-space planning to improve habitat. These programs delivered more than **4,700 educational events**, planning meetings and workshops in 2021 to more than **940,000** educational and other contacts.

- **Wildlife management** programs led to estimated economic gains of **$14.4 million** by reducing property damages from feral hogs and improving quail biology and habitat.
- **Wildlife Services' predation and beaver damage** management efforts led to **$62.3 million** in economic benefits for landowners.
- **Texas Master Naturalists** contributed **442,000 hours** of volunteer service in 2021, which was valued at **$12.6 million**.
- **Water conservation** programs produced estimated cost savings of **$15.0 million**, while **groundwater protection education** led to over **$789,000** in economic benefits for private well owners.
- Participants in **rangeland and natural resource management** programs reported anticipated economic benefits of **$32.7 million** on 15.6 million managed acres.

Through **2,700 educational events**, planning meetings and workshops in 2021, AgriLife Extension reached more than **1.3 million** educational and other contacts to increase public awareness and adoption of practices vital to improving and sustaining the state's water demand-supply balance.

The benefits of these programs are measured in terms of water saved, water-cost savings, number of jobs and annual wages for trainees in the landscape-irrigation profession, and benefits associated with watershed protection and educational programs.

- Water conservation programs have resulted in a potential savings of 4.1 billion gallons annually (enough to supply **37,500 households**), valued at **$15 million**.
- More than 20 water quality restoration efforts across Texas follow the Plum Creek Watershed model. The Plum Creek, Attoyac Bayou, and Buck Creek watersheds and parts of the Navasota River watershed have been removed from the EPA's list of impaired water bodies.
- Outreach efforts continue to support the identification of sources of contamination, educational programs, and critical water quality protection activities with economic benefits of more than **$1.4 million** in 2021.
- Programs that provide certification in landscape irrigation, onsite wastewater systems management and water quality directly support **1,890 jobs**, with **$62.4 million** in annual wages.
- The ultimate societal benefit to Texas is the protection and more efficient use of scarce water resources.

Texas Wildlife Services is a cooperative program between the USDA Animal and Plant Health Inspection Service, the Texas A&M AgriLife Extension Service and private and public partners. Its mission is to use research-based methods and education to protect Texas agriculture and other industries, natural resources, property and public health and safety from damage caused by wildlife.

- Provides services on 4,700 properties, covering 17.5 million acres. It educates property owners and residents about wildlife damage management in both rural and urban areas.

Economic impacts are measured by the reduction in property damage caused by feral hogs and other wildlife, the value of livestock and wildlife saved from predation and property protected from beaver damage.

- Directly assisted landowners in removing 47,890 feral hogs from more than 7.4 million acres, saving landowners an estimated **$14.4 million** in avoided crop and property losses.
- Predation management efforts saved an estimated **$55.4 million** in livestock and wildlife losses.
- Beaver damage management protected flood-control structures, roads, bridges, timber, crops and pastures valued at **$6.9 million**.

Critical Issue: Preparing Youth for Life and Work (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Sustainable Livestock Management (1890)

This is a critical issue for Prairie View A&M University. They will submit separately. We will move any projects associated with this critical issue to the appropriate critical issue later when NIFA gives the okay to do so.

Critical Issue: Youth Development and Leadership (1862)

Each year, more than 80,000 volunteers partner with Texas A&M AgriLife Extension professionals to dedicate their time and effort into educating youth and adults across the state. Volunteers are local residents who possess an interest in a particular subject. AgriLife Extension provides further training and expertise to increase their knowledge and skills in that subject. Volunteers then use what they have learned to facilitate and promote AgriLife Extension education programming in their local communities. AgriLife Extension's volunteer program offers endless possibilities, including the Extension Master Volunteer program. Master Volunteers teach youth or adults, train other volunteers, and work on projects around their community.

In 2021, **86,371** AgriLife Extension volunteers provided **4.3 million hours of service** valued at **$122.5 million,** which is equivalent to **2,064 full-time staff members.**

In addition to the countless number of volunteers who dedicate their time and effort to bettering themselves and their communities, AgriLife Extension also offers educational programs for elected county officials and community leaders across the state. Texas A&M AgriLife Extension's V.G. Young Institute of County Government is a valuable source of continuing education for county officials in Texas, providing accredited hours that apply toward the state-mandated continuing education requirements for county judges and commissioners, county tax assessor-collectors, and government HR professionals. The Texas Agricultural Lifetime Leadership (TALL) program is a comprehensive leadership enhancement program administered by Texas A&M AgriLife Extension. The TALL program is a two year study of agricultural issues, policies, markets and environmental issues for emerging leaders in Texas agriculture. This program was implemented to train the next generation of agriculture leaders to support our most valued national security issue — our food and fiber.

Texas A&M AgriLife Extension Services' 4-H Youth Development program prepares youth to meet the challenges of childhood, adolescence and adulthood through a series of educational experiences that enhance life skills and develop social, emotional, physical, and cognitive competencies. More than 46,000 Texas youth participate in 4-H community clubs in Texas. Over 156,000,000 are involved in 4-H through extracurricular opportunities, in after school programs or at neighborhood youth centers. 4-H allows youth a chance to pursue their own interests - from photography to computers, or building rockets to raising animals.

Merit and Scientific Peer Review Processes

Updates

None

Stakeholder Input

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

None

Methods to identify individuals and groups and brief explanation

No updates to previous submission.

Methods for collecting stakeholder input and brief explanation

Due to COVID restrictions of face to face interactions, measures were taken by AgriLife Extension to adapt the method for collecting stakeholder input. Considering the vast geographic and population variances across Texas, some communities had greater in person restrictions where other communities where more lenient.

A Coordinated Program Area (CPA) concept was piloted across seven programmatic areas of Extension. The goal was to capitalize on the work of individuals to amplify their work and the collective impact to help all Texans. The pilot was conducted to enable the agency to codify the processes that will use to launch other Coordinated Program Areas in the future.

All agency programmatic personnel will be invited to complete an online survey to identify issues affiliated with the specific program area. Information captured will include:

- Issue/topic
- Description of issue/topic
- Status:
    - New issue
    - Currently being addressed
- Source(s):
    - Local issue
    - State/national data
    - Collaborative work (with state/national partners)

- Anticipated needs
- Other (please specify)

Agents encouraged to seek input from local planning committees and constituents prior to completing the survey. They will also be encouraged to reference the Ag Increment Report, State of Health Report and State of Kids Report, as applicable.

REGIONAL FORUMS

A regional forum, face-to-face, virtually or in a hybrid setting, was held for each pilot CPA with discussion facilitated by a Regional Program Leader (RPL). The purpose of the forum is to review the issues report, discuss issues at the regional level to identify commonalities as well as differences. In the forum, participants will also categorize the prioritization level of each issue (high, medium, low).

While everything AgriLife Extension does is important, the prioritization may help identify gaps in current efforts and compare priority of issues and needs among regions.

Specialists that are regionally based participated in their corresponding regional forum. State Specialists were encouraged to participate in the regional forums with participation expected in at least one regional forum. Associate Department Heads (ADH) and Unit Leaders assigned state specialists a regional forum in which to participate to ensure representation at each regional forum.

Upon conclusion of the regional forum, one Extension agent should be selected to represent the region in the state forum.

STATE FORUM

Upon receipt of all regional forum reports and prioritizations, the CPA Coordinators hosted a State Forum (face-to-face, virtual, or hybrid). This included at least one agent from each region as well as RPLs and State Specialists identified. The purpose of the state forum is to review and aggregate data from the regional forums to develop a state issues and prioritization report for the specific CPA.

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

AgriLife Research is listening to our research stakeholders (external groups) and developing research programs which reflect the voiced needs of our stakeholders.

AgriLife Extension at the conclusion of 2021, each of the seven pilot CPAs developed a Master Plan that shared prioritized issues identified at the local, regional and state levels, outlined the future programmatic direction for each CPA, including SMART goals, an educational resource development plan, programmatic evaluation strategies, and a professional development plan. Additionally, each Master Plan provided a summary of educational resources currently available and Extension personnel working within each CPA.

Statement (Master Plan evaluation - 4 point scale)	**Average*** **Level of Agreement**
The educational resource inventory will help me address issues in my county/among stakeholders.	3.75
I think the goals set in the master plan are realistic and attainable.	3.67
I understand how the master plan will guide future programmatic direction.	3.66
The plans for personnel training are clear and will benefit those delivering educational programs.	3.57

The evaluation strategies and tools will help me strengthen the evaluation of my programs and measure the agency's collective impact.	3.57

Highlighted Results by Project or Program

Critical Issue

Adult and Community Leadership (1862)

Impact Evaluation for Evidence -Based Decision Making through Engaged Scholarship in Food, Agriculture, Natural Resources and Related Sciences

Project Director

Kim Dooley

Organization

Texas A&M University

Accession Number

1026334

Impact Evaluation for Evidence-Based Decision Making Through Engaged Scholarship in Food, Agriculture, Natural Resources and Related Sciences

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

This Hatch project is designed to refine and test an EVAL framework to enhance and promote trans- and multi-disciplinary thinking and practice as a translational (bench to community) innovation. The expected outcomes include the testing of this framework for evaluating complex projects, incorporating values and opinion leadership, and to promote project sustainability and impact for evidenced-based decision making through engaged scholarship.

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

There is a recent publication in *Advancements in Agricultural Development* to establish the EVAL framework as a method for training evaluation scholars. https://doi.org/10.37433/aad.v2i3.139

A presentation was given at the International Leadership Association Conference in Geneva, Switzerland promoting the model for sustaining projects with leadership development for impact evaluation. Another international presentation to the Association for International Agricultural and Extension Education on impact evaluation for evidence-based decision making through engaged scholarship in food, agriculture, natural resources, and related sciences will be presented in April 2022. The EVAL framework is being used as the external evaluation model on several federal (NSF, USDA) grant projects to test the framework.

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

The primary stakeholders are scientists, community health directors, agricultural teachers (high school and college), underserved populations in STEM disciplines, extension, and workforce development. The primary benefit was increased collaboration of social and behavioral scientists in evidenced-based decision-making. We are also increasing skills to promote impact evaluation within organizations.

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

As we test the EVAL framework, there is local knowledge and leadership development components to sustain projects within communities. This will increase engagement of users and beneficiaries in evaluation processes.

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

Framework results have been disseminated in the following ways:

Strong, R., Dooley, K. E., Murphrey, T., Strong, J., Elbert, C. & Baker, M. (2021). The EVAL framework: Developing impact evaluation scholars. *Advancements in Agricultural Development, 2*(3), 1-13.

https://doi.org/10.37433/aad.v2i3.139

Dooley, K., Strong, R., Murphrey, T., Strong, J., Elbert, C. & Baker, M. (accepted, 2022). *Impact evaluation for evidence-based decision making through engaged scholarship in food, agriculture, natural resources and related sciences.* Abstract for the AIAEE conference, Thessaloniki, Greece.

Dooley, K. E., Strong, R., Strong, J. & Murphrey, T. (2021). *Sustaining projects with leadership development for impact evaluation: Developing an EVAL framework*. International Leadership Association Conference, Geneva, Switzerland.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Impacts: This Hatch Project uses a researcher-developed approach for impact evaluation. This EVAL framework includes four constructs: Evaluation, Values, Active Learning, and Leadership Development.

Monitoring and evaluation are a continuous management function to assess if progress is made in achieving expected results or outcomes. It is referred to as “Result-Based Management” (RBM) intended to aid decision-making towards explicit goals and results that matter.

The EVAL approach will measure short, medium, and long-range goals to determine program sustainability through the life cycle of a project. This theoretical approach is currently being field tested in two contexts: Behavioral Plasticity Research Institute (NSF) and a USDA-AFRI project entitled Get AgSmart: Building Capacity in Smart Agricultural Technologies for Underserved Communities.

Impact 1: Evaluations grounded in clear and appropriate values that are conducted in diverse settings within communities will increase engagement, co-creation of new knowledge, communication pathways, and culturally relevant adoption to increase project sustainability.

Impact 2: Including the attributes of an innovation (Rogers, 1995) with active and experiential learning will foster positive attitudes, develop new stakeholder competencies, and promote broader applications of concepts and models within a community.

Impact 3: The addition of active learning applications and reflection of leadership theory and practice will enhance community engagement and development for project sustainability. Project success is determined by more strategic dimensions, positive impact on the team and stakeholders, and better community preparation for the future.

Impact 4: Engaging in knowledge transfer about the strengths and weaknesses of approaches in all stages of the evaluation process will increase evidenced-based decision making.

Impact 5: Determining generative causation of successful programs will enable evaluators to make causal links between the contribution of an intervention and the observed effects to improve translational and team science communication and collaboration in cross-disciplinary teams and communities.

Developing Ethical Leadership Through Critical Thinking

Project Director

Barry Boyd

Organization

Texas A&M University

Accession Number

1026809

Developing Ethical Leadership Through Critical Thinking

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

There is a lack of instruments that measure critical thinking that can be used in a pre-test, post- test or post-then-pre format. There are also no instruments that measure critical thinking behaviors that are based on a critical thinking model.

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

The directors of this project created a behavior-based critical thinking model (QUEEN Critical Thinking Model) with an instrument that measures those behaviors. The model can be used as a framework to teach critical thinking behaviors and use the QUEEN Student Self-Assessment tool to measure the growth in those behaviors. This instrument is being validated and implemented as a tool in institutional assessment of critical thinking.

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

The QUEEN Critical Thinking Model has been used as a framework for teaching critical thinking in leadership majors. Students have demonstrated growth in critical thinking behavior as a result of purposeful teaching of critical thinking behaviors. The QUEEN Student Self-Assessment tool has been used in institutional assessment to measure student growth in critical thinking behaviors.

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

Employers will benefit from having graduates with the essential skill of critical thinking, as more instructors adopt the QUEEN Model of Critical Thinking. Institutions will be able to document growth in critical thinking behaviors among their graduates as part of their institutional assessment using the QUEEN Student Self-Assessment tool.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Employers expect colleges and universities to prepare work-ready graduates. Key among the skills sought by employers is the ability to think critically. Most employers believe that college graduates are deficient in critical thinking skills. Additionally, available critical thinking assessments for use in the classroom are expensive to use or are inappropriate as formative assessment tools.

The development of the QUEEN Critical Thinking Model and QUEEN Student Self-Assessment tool has allowed instructors to demonstrate the impact of teaching for critical thinking and measure student growth in critical thinking behaviors. Students in an upper-level applied ethics course (N=302) demonstrated significant growth in critical thinking behaviors over the course of one semester. The QUEEN assessment tool is being expanded for use at the University of Florida and other departments at Texas A&M University this fall.

Critical Issue

Agriculture Production (1862)

Combining Molecular and High-throughput Phenotyping Breeding Approaches to Improve Yield, Quality and Disease Resistance in Tomato and Spinach.

Project Director
Carlos Avila
Organization
Texas A&M University
Accession Number
1026646

Texas A&M tomato and spinach germplasm developed using novel high throughput phenotyping and molecular tools have high yield, resistance to diseases, and high quality

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

Production of tomato and spinach is threatened by high pressure of endemic or new pests and diseases that severely limit production. In addition, high quality produce in terms of appearance, flavor, nutritional content, and postharvest shelf-life are needed to satisfy consumers demands. In tomato, several major resistance genes varying on the control level for Tomato Yellow Leaf Virus (TYLCV) have been identified but need to be stacked into locally high yield-heat tolerant adapted cultivars to ensure long-lasting disease resistance. In spinach, endemic and emergent diseases such as Anthracnose (*Colletotrichum dematium*) and white rust (*Albugo occidentalis*) diseases in the Texas Wintergarden area have result in up to 100% loss in some fields. Consequently, improved cultivars need to be developed to maintain the industry competitive. Therefore, new tools need to be developed to speed up trait introgression and cultivar development. The vegetable-breeding program is developing high-throughput phenotyping and molecular methods to develop high-yield, heat-tolerant, disease- and pest-resistant, nutritious high-quality long shelf-life tomato and spinach cultivars.

Project objectives include:

i. Introgress and characterize resistance genes in Texas A&M germplasm.

ii. Improve fruit nutritional content, firmness and post-harvest shelf-life in tomato

iii. Enhance vitamin C (Ascorbic Acid) content in spinach

iv. Evaluate the nutritional potential of spinach seed for grain production

v. Develop high throughput phenotyping methods as breeding tool for tomato and spinach characterization and trait evaluation.

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

- The Texas A&M vegetable breeding program in Weslaco developed several new specialty and beefsteak and specialty tomato F1 hybrids with resistance to Texas endemic diseases resulting in high potential yield and quality characteristics. Hybrids were tested under field and protected structure environments showing that under Texas conditions, Texas A&M cultivars performed better than commercial controls. Evaluated hybrids included 11 new Texas A&M Cherry-type and 90 beefsteak tomato hybrids. Best performing hybrids will be registered and advanced for extended trials and release.

- The vegetable breeding program at Weslaco identified a new trait for fruit firmness in tomato. Firmness trait confers exceptional fruit firmness beyond the expected firmness range. It was determined that trait is conferred by a single recessive gene that results on lack of gel, higher dry matter, and long-shelf life. Therefore, identified a fruit firmness trait that can be used to substantially improve fruit flavor and shelf- life characteristics, meeting both consumers' and retailers' demands on fruit quality.

- The vegetable breeding program in a continuous effort to develop new strategies to improve selection and introgression of novel traits for cultivar enhancement, identified vitamin C content associated markers for molecular breeding in spinach, a machine learning method to select root architectural traits associated with nitrogen-use

efficiency, and a high throughput phenotyping for aerial screening of water-use efficiency in spinach. Developed methods can be applied to multiple other traits and are expected to significantly improve cultivar efficiency in spinach and other leafy greens.

- The vegetable breeding program evaluated the use of spinach seed for grain consumption as a potential source of additional income for growers at the end of the season when fresh leaves are already harvested or in the event of disease pressure when fresh leaves cannot be commercialized. Our initial work indicates high yield potential and nutritional quality in spinach seed suitable for human consumption. Further evaluation trials are under way.

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

- Spinach producers and industry representatives were shown and trained on current efforts on disease management and cultivar development production during field day. Disease management included commercial and breeding line white rust and anthracnose evaluation trial results, screening of new sources of disease resistance, and chemical control trials. Field day was held at Tiro Tres Farm at Cristal City, TX in collaboration with the Texas Wintergarden produce association with a participation of >50 attendees including producers, seed companies, research faculty, industry representatives. A handout having detailed results was given.

- Spinach seed nutritional quality: Traditionally just the leaves of the spinach are eaten, although the seeds are also edible. Therefore, in addition to the production of spinach as a leafy green, production of spinach seed for grain can be an option as a potential source of additional income for growers at the end of the season when fresh leaves are already harvested or in the event of disease pressure when fresh leaves cannot be commercialized.

- Development of heat-tolerant, disease-resistant germplasm adapted to Texas conditions: the main disease affecting tomato production in South Texas is the Tomato Yellow Leaf Curl Virus (TYLCV), vectored by whiteflies. Several major resistance genes are available, but none of them confers complete immunity to TYLCV. The vegetable breeding program at Weslaco stacked multiple sources of resistance into heat-tolerant adapted germplasm to obtain adequate levels of resistance. The resistant hybrids developed produce on average 30-40 tm/ha in our evaluation fields as compared to 25 tm/ha from historical yields in the area. This increase in production is equivalent to an additional income of $6,900 to $10,300 per ha if selling at minimum price making production economically viable. Developed material is currently being evaluated as part of a multiple location and year trials at research and producer fields as part of Texas A&M efforts towards making tomato industry more competitive.

- Optimization of tomato productivity and quality with protected culture and Texas A&M elite germplasm: South Texas high temperature, strong winds, and high pressure of endemic/new insects and diseases in the area limit tomato production. To address this, the vegetable program at Weslaco tested a combination of TAMU hybrids and new cultural techniques, including the use of high-tunnels and net-houses. The combination of hybrids and protected structures in experimental and commercial conditions increased yields by ~36-45 tm/acre as compared to open field production. This increase in yield is equivalent to $34,500 of additional income per ha selling at minimum price. Since protected structures allow Winter production when selling tomato prices are high and production on other areas is low, increase in profit can be higher depending on selling price. These levels of income combined with better fruit quality have the potential to make Texas industry competitive

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

- Scientific community and breeding programs have been benefited from the publication of 11 articles in peer reviewed scientific journals. Published articles included data on molecular markers to improve selection efficiency in tomato and spinach, new developed technologies for high throughput phenotyping utilization in cultivar development. This work has established a strong foundation for high-throughput phenotypic selection in spinach and potentially other leafy green vegetables to optimize marker and cultivar development. A total of 143 publications citing our work were reported during 2021.

- Upon release, new tomato and spinach cultivars with enhanced resistance to diseases, improved quality, and long post-harvest shelf-life will contribute to maintain local industry competitive ensuring constant supply of flavorful and nutritious produce that incentivize consumption and improve health eating habits.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

- Texas A&M AgriLife tomato heat-tolerant, disease-resistant hybrids produce on average 35-40K lbs/A under open field conditions as compared to 22K lbs/A from historical yields in the Rio Grande Valley. This increase in production is equivalent to a minimum additional income of $5.7K/A. ?

- Developed hybrids grown in high tunnels during the winter offseason increased yields by additional 53K lbs/A (75K lbs/A total) as compared to open field production equivalent to a minimum of $23K/A of additional income. ?

- Traditionally, breeding for shelf-life results in lower tomato quality. Newly identified firmness trait keeps quality for 21 days even when harvested completely ripe and stored at room temperature. Hybrids carrying the trait increased soluble and acid contents by 10%, 30% firmness, 15% dry weight, and 67% yield. Trait can be used to improve flavor, nutritional content, and shelf-life to meet consumers and retailers demands.

Sensor-based water stress assessment for high-throughput plant phenotyping and optimized water management

Project Director
Wenxuan Guo
Organization
Texas A&M University
Accession Number
1026191

Precision agriculture and high-throughput plant phenotyping for water conservation and sustainable agricultural production

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

Diminishing water resources and inadequate water management pose severe threats to agricultural sustainability and socioeconomic stability in semi-arid regions. High-throughput phenotyping provides critical information for accelerating breeding efficiency in developing water stress resistant cultivars. Quantification of environmental factors influencing crop yield assists in maximizing water use efficiency, improving water conservation, enchaning economic return, and protecging the environment.

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

1). Quantified crop yield variation in relation to irrigation rates as affected by topography and soil physicochemical properties for decision support in site-specific irrigation management. This study suggests that applying irrigation amounts based on the yield response to slope and soil texture can be a basis for VRI.

2). Developed a new vegetation index to incorporate soil texture and unmanned aerial system (UAS) images in estimating surface soil water content. A vegetation index (NDVI) and soil surface temperature derived from UAS images were employed to construct the texture temperature vegetation dryness index (TTVDI). This new index improves the accuracy of estimating surface soil water content by 15%.

3). Developed an algorithm to count cotton seedling plants from high-resolution images using machine learning algorithms. This study applied two deep learning models, the MobileNet and CenterNet, to detect and count cotton plants at the seedling stage with UAS images. This study provides valuable information for selecting the right deep learning tools and the appropriate number of training images for object detection projects in agricultural applications.

4). Evaluated spatial variability of soil calcium at the field scale to reveal soil water and wind erosion and soil health management. This study assessed soil Ca in relation to topography, hydraulic attributes, and soil types in a field in the Southern High Plains, indicating that surface soil loss may occur due to water or wind erosion, especially on susceptible soils with high slopes. The results of this study provide valuable information for site-specific soil conservation and crop management.

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

Our research findings provide valuable information for decision support in precision water and soil health management. In 2021, my publications were cited 88 times by diverse researchers, demonstrating a strong impact on the research community.

Producers can practice site-specific irrigation to optimize crop production in fields with significant variability in soil physical properties and topography. For example, a participating producer has started to perform variable rate irrigation to improve profitability and conserve water based on our research. The impact on the farming community and the industry is demonstrated by the continuous participation and support of two progressive producers and two precision agriculture companies.

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

These discoveries have led to a $300,000 grant over the next three years by Texas Tech University and Texas A&M AgriLife Research and Extension to continue developing new precision irrigation strategies and technologies to address challenges in water-limited crop production under a changing climate in the Southern High Plains. The research team hopes that expanded efforts will facilitate enhanced water conservation, improved breeding efficiency in developing water-stress resistant cultivars, improved production profitability, and better protection of the agroecosystems. New developments will also provide critical information for other regions in the U.S. and similar environments in the world to conserve water and develop resilient cropping systems for sustainable agriculture.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Our research findings provide valuable information for decision support in precision water and soil health management that improve water use efficiency and conservation. These discoveries have led to a $300,000 grant for developing new precision irrigation strategies and technologies to address challenges in water-limited crop production under a changing climate in the Southern High Plains. The expanded efforts will facilitate enhanced water conservation, improved breeding efficiency in developing water-stress resistant cultivars, improved production profitability, and better protection of the agroecosystems. New developments will also provide critical information for other regions in the U.S. and similar environments in the world to conserve water and develop resilient cropping systems for sustainable agriculture.

Methods to Increase Reproductive Efficiency in Cattle

Project Director
George Perry
Organization
Texas A&M University
Accession Number
1024679

Improving reproductive by increasing embryo survival in beef cattle

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

Reproductive performance has a substantial effect on the overall efficiency feed use in livestock production by all species, especially in cattle. In addition, reproductive failures cost the beef and dairy industries over $1 billion annually, and specifically pregnancy loss after a single service is 40 to 50% for beef cows and heifers through day 30 of gestation. If pregnancy maintenance can be increased by just 10%, beef production would be increased by ~3,100 pounds per 100 cows (31 lbs/cow).

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

Vaccination is a tool that can be used to optimize immunological function and protection, which is imperative for the appropriate growth and performance of beef cattle. However, the influences of type and timing of vaccine administration relative to ovarian function and pregnancy success are considerations that must be made to optimize pregnancy success. Work from our program had demonstrated that vaccination with a modified live virus vaccine negatively impacted luteal function and pregnancy success for at least45 days post vaccination by altering progesterone production and estrous cycle length.

Stress can have harmful consequences on reproductive success; not only for the current pregnancy (increasing the incidence of embryonic loss) but possibly for subsequent generations. Our laboratory has been investigating the role of a mild stress during pregnancy (hauling on a trailer for 2 hours four times during pregnancy) on embryo development and transgenerational impacts. Prenatal stress does not impact the ovarian reserve in female offspring. Among male offspring no difference has been detected in performance, but semen produced by males stressed in utero had ability for early embryo development, indicating these embryos are more likely to die. Thus, stressful events during pregnancy may not impact the current breeding season but may impact pregnancy success for years to come.

Pregnancy loss after a single service is the single greatest economic loss for beef and dairy cows. Preovulatory estradiol concentrations and expression of estrus have been associated with greater pregnancy maintenance. Work from our laboratory has demonstrated that day 30 pregnancy rates were not different between animals that exhibited estrus or were give supplemental estradiol (41**%** and 36**%**, respectively) but animals that did not exhibit estrus and were not given supplemental estradiol had decreased pregnancy success (27**%**). Thus, preovulatory estradiol may be eliciting an effect that better prepares the conceptus for embryo survival.

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

Recently, the American Association of Bovine Practitioners developed Vaccination Guidelines to utilize when designing vaccination protocols. This is the first time a food animal veterinary group has developed official vaccination guidelines, and work from our laboratory is highlighted in the impact of vaccinating during the prebreeding period. These new guidelines demonstrate the impact of vaccination during the prebreeding period on the cattle industry. This research has the potential to change the current dogma thus have a tremendous long-term impact on the cattle industry.

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

The Beef industry makes up roughly 22-24**%** of the total meat produced worldwide, and with it being estimated that the world's population will exceed 9 billion by 2050; food production must more than double to meet the growing world demand. The greatest benefit for the beef industry is its ability to convert low quality forage (which is not usable for human food) into a high-quality food source for humans. However, as the world population increases, resources available for beef production become even more limited. Therefore, the efficiency of beef production must increase to meet the rising demand. It has been estimated if pregnancy maintenance can be increased by just 10**%**, beef production would be increased by ~3,100 pounds per 100 cows (31 lbs/cow). Thus, an improvement in embryonic survival by 10**%** from 50**%** to 60**%** would increase the number of pregnant beef cows in the United States by 3.12 million head (31.2 million beef cows x 0.10 = 3.12 million). This would translate into an economic impact of roughly $1.45 billion (31 lbs/cow x 31.2 million cows = 967,200,000 lbs x $1.50/lb = $1,450,800,000 million). Thus, management systems to increase embryonic survival and fertility will have an enormous impact on supplying beef to the world and a tremendous economic impact as well.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The Beef industry makes up roughly 22-24**%** of the total meat produced worldwide, and with it being estimated that the world's population will exceed 9 billion by 2050; food production must more than double to meet the growing world demand. The greatest benefit for the beef industry is its ability to convert low quality forage (which is not usable for human food) into a high-quality food source for humans. However, as the world population increases, resources available for beef production become even more limited. Therefore, the efficiency of beef production must increase to meet the rising demand. It has been estimated if pregnancy maintenance can be increased by just 10**%**, beef production would be increased by ~3,100 pounds per 100 cows (31 lbs/cow). Changes in current management practices can greatly increase the percentage of cows that conceive early in the breeding season and maintain their pregnancy. Utilizing a modified live vaccine resulted in greater than 20**%** of

animals having an abnormal estrous cycle, and by utilizing an inactivate viral vaccine during the prebreeding period AI conception rates were increased by 5 to 8%. Furthermore, by vaccinating more than 45 days before the start of the breeding season conception rates were increased by greater than 10%. Increasing the numbers of animals detected in estrus (having a natural rise in estradiol) before insemination resulted in increased embryo survival. Pregnancy rates on day 30 of gestation (day 23 after embryo transfer) were not different between animals that exhibited estrus or were give supplemental estradiol (41% and 36%, respectively) but animals that did not exhibit estrus and were not given supplemental estradiol had decreased pregnancy success (27%). Thus, preovulatory estradiol may be eliciting an effect on the uterus that better prepares the conceptus for embryo survival. Stress can also have harmful consequences on reproductive success; not only for the current pregnancy (increasing the incidence of embryonic loss) but possibly for subsequent generations. Our laboratory has also been investigating the role of a mild stress during pregnancy (hauling on a trailer for 2 hours four times during pregnancy) on embryo development and transgenerational impacts. Prenatal stress did not impact the ovarian reserve in female offspring. Among male offspring no difference has been detected in performance, but semen produced by males stressed in utero had reduced ability for early embryo development, indicating these embryos are more likely to die. Thus, stressful events during pregnancy may not impact the current breeding season but may impact pregnancy success for years to come. Thus, changes in current management practices can result in an improvement in embryonic survival by as little as 10% from 50% to 60% it would increase the number of beef cows pregnant early in the breeding season in the United States by 3.12 million head (31.2 million beef cows x 0.10 = 3.12 million). This would translate into an economic impact of roughly $1.45 billion (31 lbs/cow x 31.2 million cows = 967,200,000 lbs x $1.50/lb = $1,450,800,000 million). Thus, management systems to increase embryonic survival and fertility will have an enormous impact on supplying beef to the world and a tremendous economic impact for the United States as well.

Closing Out (end date 09/07/2023)

Fly Management in Animal Agriculture Systems and Impacts on Animal Health and Food Safety

Project Director
Philip Kaufman
Organization
Texas A&M University
Accession Number
1024127

Result

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

House flies and stable flies are major pests of not only livestock, but also of humans living near animal agriculture production areas. This multi-state project seeks to develop new fly management technologies, investigate insecticide resistance in these flies, identify the role of the flies in food-borne illness and provide a portal to extend our findings and other existing knowledge through a modern Internet-based system.

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

Our group works in two areas of this large project, stable fly resistance and extending knowledge through our Internet presence. As such, we are exploring new resistance mechanisms in the stable fly to broaden our understanding of how this fly survives exposure to insecticides. We are establishing a new Texas strain of the stable fly that will complement our two Florida-developed strains. The recent publication of the stable fly genome will greatly enhance our ability to look for additional resistance mechanisms. With our new fly strain, we will begin selecting for resistance to permethrin and make comparisons to our existing strains through collaborative research with the USDA-ARS scientists on this project. We have developed and continue to add content to our Internet site that includes information on pests, their management, “how to” videos, and other engagement tools, as well as keeping our pesticide database updated.

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

Through our selections for resistance, we have identified a change in the genetics for the “target site” of the flies that allows for a moderate elevation in survival when exposed to the commonly used insecticide permethrin. However, through project collaborator research in flies sampled from around the world other target site locations in the fly genome have emerged that

may confer additional resistance not yet seen in the U.S. Because of the knowledge developed to date, we can advise that typical enhancements to insecticides will not improve fly control, as the resistance cannot be overcome by adding synergist-type products. For our Extension website, we have provided considerable information in a variety of formats to deliver pest management information to our clientele. Collectively, we published multiple peer-reviewed articles that highlight the challenges and opportunities surrounding the flies we study, and my program was involved with three of these papers.

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

We believe that our Extension website had provided a modern portal for anyone seeking information on the pest flies we study, as they are more than just livestock pests. We also developed an animal pesticide database to improve the proper use of pesticides on animals (correct product on the correct animal/facility). With our improved understanding of the insecticide resistance in this fly we have increased the capacity for appropriate pest management. Although the stable fly is a pest of livestock, it also bites humans and dogs. Reductions of flies through our improved pest management strategies improves animal health and may reduce human biting incidence near animal operations.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

1. A broad effort including other S-1076 members published a manuscript to annotate and analyze the stable fly genome. This provides the pest fly community, and fly research community in general, with new genetic resources for the management and study of this pest fly. Graduate students were trained in how to annotate genes. In addition, repeat element identities and distributions throughout the genome were identified, which is informative of chromosomal evolution and this new knowledge helps researchers best plan genetic control efforts.

2. Provided novel information regarding the immune response of larval Lucilia sericata to the pathogens Pseudomonas aeruginosa and Acinetobacter baumannii. This enhances understanding of how to better implement wound debridement therapy and informs pest fly researchers about the molecular dynamics of filth fly interactions with pathogenic bacteria.

3. Members of the S-1076 team, including TAMU members, published 5 manuscripts in 2021 that highlighted the research needs and the economic impacts of several fly pests on the livestock industry. We continue to update our collective website, https://www.veterinaryentomology.org/, with new information that provides improved stakeholder support.

Sustainable Limited Irrigation and Dryland Cropping Systems in the Semi-Arid Southern Great Plains

Project Director
Craig Bednarz
Organization
Texas A&M University
Accession Number
1024516

Results

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

Crop irrigation accounts for 95% of total withdraws from the Ogallala, equating to 30% of all crop irrigation in the United States. Since the 1990's, dryland crop production has expanded to encompass 45% of all crop value in the United States, allowing greater conservation of irrigation water for municipal and commercial demands. The objectives of this investigation are to determine if extended fallow with no-till cover crops may improve precipitation capture, annualized cotton yields and profitability in a rain fed cropping system.

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

Rainfall recorded from May 1, to September 30, 2021 totaled of 274.572 mm. September 8, 2021 soil moisture data were recorded with a neutron moisture meter. Earlier in the summer two NMM access tubes were installed in each plot. Data were analyzed using the Glimmix procedure. Volumetric moisture content was significant for crop, soil depth and the interaction of crop x soil depth. Across depths, the cotton plots on this date were 21.65 % moisture (v/v), the rye plots were 27.6% moisture

(v/v) and the wheat plots were 25.24% moisture (v/v). Across depths, all crops differed in soil moisture on this date. The rye plots were likely highest due to the fact that these plots were terminated with glyphosate on May, 7, 2021. At this time the wheat plots were maturing but still using water. The cotton plots were lowest for percent moisture because the crop was actively growing throughout the summer. Soil moisture data across crops suggested moisture content was lowest at the 20 cm depth interval but from 40 cm to 120 cm decreased with increasing depth. Volumetric soil moisture was greatest in the rye plots at the 40 and 60 cm depths followed by the same depths in the wheat plots. Soil moisture at this depth interval in the cotton plots was lowest. At the 80 cm depth interval the rye plots were highest in percent moisture. Differences in soil moisture were not detected among crops at the 100 and 120 cm depths. The wheat and rye plots were higher than cotton at the 20 cm depth. Assuming 18 % (v/v) is the permanent wilting point, total plant available water on this date was 4.4 cm, 9.2 cm, and 11.5 cm in the cotton, wheat and rye plots respectively.

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

This research may lead to more widespread adoption of cover crops in West Texas through increased production efficiency, improved best management practices, improved economics and improved crop water use efficiency.

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

This research will conserve water for future generations by reducing agricultural water pumping from the Ogallala Aquifer.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The Ogallala Aquifer is the largest underground water reservoir in the United States. It covers 174,000 square miles in Nebraska, Kansas, Oklahoma, Texas, South Dakota, Wyoming, Colorado and New Mexico. The Ogallala is a major source of water for agricultural, municipal and industrial development on the High Plains. Unfortunately it is being depleted as withdrawals exceed recharge.

With assistance from the Chancellor's Research Initiative, the Semi-Arid Agricultural Systems Institute (SAASI) at West Texas A&M University in cooperation with Texas A&M AgriLife Research and USDA/ARS/CPRL in Bushland, TX is developing scientifically vetted and practical solutions for improved sustainability of rain fed and limited irrigation production agriculture systems in the Texas Panhandle. Meeting this challenge in the years ahead will require implementation of improved soil health management systems such as cover crops and no tillage. Judicious use of the regions water resources coupled with improved soil health management practices will not only conserve the Ogallala Aquifer for future generations, but will also improve the quality, profitability and sustainability of Panhandle agriculture. The mission of SAASI is being fulfilled through research efforts such as: (1) integration of small unmanned aerial system (sUAS) based tools for more efficient agricultural irrigation management (2) evaluation of alternative crops for improved water use efficiency and drought tolerance and (3) development of rain fed cropping systems for improved resiliency, productivity and profitability of Panhandle agriculture. Current results suggest (1) sUAS derived vegetation indices may be used as a proxy for canopy temperature for improved irrigation management in cotton and (2) wheat or rye crop residue may enhance precipitation capture during summer fallow periods when compared to conventional tillage.

Closing Out (end date 09/07/2023)

Improving turfgrass and urban agriculture production through genomic research

Project Director

Qingyi Yu

Organization

Texas A&M University

Accession Number

1024469

Dissecting the molecular mechanisms underlying salt secretion in zoysiagrass

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

Soil salinity is one of the most devastating environmental factors limiting plant growth and productivity worldwide. The effective solution to combat soil salinity is not only to develop crop varieties with increased tolerance to salt stress, but also to mitigate the accumulation of salt in soils. Plants that can secrete excess salts through salt glands, such as zoysiagrass (*Zoysia* spp.), possess special anatomical features as well as physiological processes which are well suited to cope with saline environments.

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

A reliable phenotypic evaluation of a quantitative trait is crucial for accurate quantitative trait locus (QTL) analysis and genome-wide association studies (GWAS). We developed a simple and efficient *in vitro* assay that can accurately measure salt secretion in zoyisagrass. The new method is much more reliable than previously used leaf-washing methods. The new method will be used to evaluate the salt secretion trait in mapping populations to map QTLs associated with salt secretion in zoysiagrass, and will also assist breeding selection for developing new salt tolerant varieties.

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

The new method can be used to evaluate the salt secretion trait in mapping populations and assist to map QTLs associated with salt secretion in zoysiagrass. The new method can also assist breeding selection for developing new salt tolerant varieties.

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

Soil salinity is one of the most devastating environmental factors limiting plant growth and productivity worldwide. Approximately 20% of total cultivated and 33% of irrigated agricultural land are severely affected by salt worldwide and the affected area continues to increase each year. Most agriculture crops are sensitive to salinity and cannot achieve their genetic potential for growth, development, and yield under salt stress. In addition to affecting agriculture production, soil salinity has significant negative impacts on water quality, wildlife habitat, biodiversity, soil erosion, etc. The effective solution to combat soil salinity is not only to develop crop varieties with increased tolerance to salt stress, but also to mitigate the accumulation of salt in soils. Plants that can excrete salts through salt glands not only have a great potential to be used for crop production under saline conditions, but also can be utilized in remediation of salt-affected soils. Results generated from the proposed project will enhance our understanding of regulatory networks underlying salt secretion in zoysiagrass and will assist breeders to select the most relevant genomic targets for developing new salt-tolerant turf varieties.

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

N/A

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Soil salinity is a global land degradation concern and has become a serious threat to global agriculture. Approximately 20% of the world’s agricultural production area and 50% of irrigated areas are exposed to salinity, causing a global economic loss of about $12 billion per year in the agricultural sector. The effective solution to combat soil salinity is not only to develop crop varieties with increased tolerance to salt stress, but also to mitigate the accumulation of salt in soils. Zoysiagrass can excrete salts through folia salt glands and has a great potential to be used for production under saline conditions and can also be utilized in remediation of salt-affected soils. We developed a simple and efficient in vitro assay that can accurately measure salt secretion in zoyisagrass. The new method is being used to evaluate the salt secretion trait in mapping populations for association studies and dissecting the molecular mechanisms underlying salt secretion in zoysiagrass.

Utilization of Biotechnology to improve crop plants and to modify plants for novel applications

Project Director

Keerti Rathore
Organization
Texas A&M University
Accession Number
1024225

Utilization of Biotechnology to improve crop plants and to modify plants for novel applications

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

I propose to utilize genetic engineering and gene editing tools to improve important crop plants including cotton, potato, rice and sorghum. The goals of the research are to make crop plants more productive while requiring lower inputs, more resistant to biotic and abiotic stresses, and enhance crop value by improving food safety and nutritional quality.

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

1. Enhance the Safety and Nutritional Value of Cottonseed by Eliminating Gossypol. We have generated ultra-low gossypol cottonseed (ULGCS) that has been deregulated by USDA-APHIS and approved by FDA for food and feed use. For its wider acceptance around the globe, we have mutated the linked nptII gene and rendered it non-functional. This antibiotic resistance gene was part of the original transformation construct and was linked to the RNAi silencing cassette at the integration site. This was accomplished by using the CRISPRCas9 system. With the aim of eliminating gossypol from the cottonseed, we will also utilize cisgenic transformation constructs wherein all the components are derived from the cotton genome.

2. Cotton Plants Resistant to Boll Weevil (BW). We had identified three BW genes whose silencing is expected to inhibit growth, development and functioning of this pest. We have generated several cotton RNAi lines targeting each of these three BW genes. Progeny from these lines will be tested against BW larvae by our entomologist collaborators.

3. ptxD/phosphite System to Control Weeds. A refined ptxD over-expression construct is being introduced into cotton plants. These plants will be examined for their ability to outcompete weeds under phosphite fertilization regimen, first under greenhouse conditions and then in the field.

4. In a different project, we have used CRISPR/Cas9 technology to knockout GBSS gene in potato with the intention of eliminating amylose levels from tuber starch, thus increasing the levels of amylopectin. Amylopectin has many industrial uses as a gelling agent, thickner and emulsifier. Many edited events have been obtained that are being analyzed at molecular and biochemical levels.

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

We have published some of the results and several other papers are under review for publication. We are also talking to several biotech companies with the expectation that they will pick up the ULGCS trait and incorporate it with other biotech traits and make the seeds available to the farmers who can then benefit from higher value for their seeds in addition to what they normally derive from selling the fiber.

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

We have made significant advances in the area of crop improvement using modern biotechnology tools. Most of the results from this work have been published and could become the basis for new products in the future. One product (ULGCS) stands out as only the fourth bioengineered crop produced by a University scientist to receive deregulation from USDA-APHIS and approval from FDA. Its eventual global adoption will benefit cotton farmers as they will get more value for the same crop. The gossypol-free, safer cottonseed should serve as an excellent source of feed protein for various animals including the poultry, swine and aquaculture species that are a source of more efficient meat protein. ULGCS, as an additional source of inexpensive protein because it will be a byproduct of fiber production should indirectly help the environment by reducing deforestation and overharvesting of the oceanic forage fish, both currently overexploited to meet the demand for feed protein.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The 2019 production of ~45 million tons of cottonseed contained more protein than the ~1.6 trillion hen eggs produced globally that year, however, the presence of toxic gossypol prevents its use for human nutrition. Cotton was engineered to selectively eliminate toxic gossypol from the seed without altering the levels of this protective chemical in rest of the plant, thus retaining the plant's defensive capabilities. It now becomes possible to utilize the ~10 million tons of cottonseed protein safely to improve human nutrition. If used directly as food, it can meet the basic protein requirements of ~500 million people. This is especially important for cotton-growing, developing countries. Indirectly, it can be used as feed for poultry and aquaculture species that are highly efficient in converting feed protein into edible animal protein. Its global adoption has the potential to significantly improve nutrition security and boost farmers' income without requiring additional input or acreage under cultivation. Global adoption of ULGCS as a protein source will have indirect environmental benefits by helping to reduce deforestation and overexploitation of oceans for forage fish, both activities currently underway to support the growing feed demands from poultry and aquaculture industries.

Molecular and Omics Approaches to Elucidate Plant Stress Signaling and Crop Improvement

Project Director
Kranthi Kiran Mandadi
Organization
Texas A&M University
Accession Number
1023984

Development of new tools and strategies to advance crop stress biology and improvement.

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

Biotic and abiotic stresses cause tremendous losses to agricultural production and productivity. This project is addressing this issue by advancing our understanding of how plants respond to and mediate stress signaling. The knowledge can be further utilized to develop new strategies for crop improvement via biotechnology and plant breeding.

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

We developed new tools and technologies that have allowed us to characterize unculturable plant pathogens that cause devastating diseases such as citrus greening, potato zebra chip, and other viral diseases. Additionally, we characterized new genes, pathways, and markers that media plant stress responses, the knowledge that is useful for crop improvement and breeding.

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

- Scientific community: The discoveries and technologies from this project advanced the collective knowledge base and tools available for the scientific community to study plant diseases and stresses. We have disseminated the knowledge through multiple peer-reviewed publications, presentations at scientific conferences, workshops, and abstracts. The scientific community can use the tools and knowledge to further devise new strategies to control devastating plant diseases and enhance plant health.

- Producer/Industry stakeholders. Project findings and results were also periodically shared with allied industry representatives, stakeholders, and partners. This kept them abreast of many of the cutting-edge discoveries happening in the laboratory and potential new products that could be deployed into the field to improve crop productivity.

- Early career researchers. The project also provided training and professional development for multiple early-career postdoctoral research associates, research scientists, and students. Many of them are Hispanic-minority females who were first in college. All the staff and students were mentored by the PI and senior scientists in the lab. They were also encouraged to present and discuss the project activities in weekly lab meetings, journal clubs, as well as scientific conferences. These activities enhanced their critical thinking abilities and presentation skills, which ultimately help them advance their career in the sciences.

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

The project activities enabled discoveries and knowledge that can be used to control devastating plant diseases and stresses of citrus, potato, tomato, spinach, and other food crops. The broader benefits to the public include the potential saving of our food supply chains and food security. Additionally, the various project activities resulted in the creation of new jobs, and research spending that contributed to the regional economy.

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

The unforeseen COVID-19 pandemic had been a setback for much research, teaching, and outreach activities. Despite this, we made considerable effort to disseminate the knowledge gained to communities of interest in peer-reviewed journals, workshops, grower meetings, and virtual scientific conferences.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Fastidious (or unculturable) pathogens cause devastating plant diseases such as citrus greening, potato zebra chip, and pierce's disease of grapes. A technology (microbial hairy root system) was developed which enabled four to six times faster efficacy screening of potential therapies. The technology is being utilized by >10 public- and private-sector stakeholders to speed the discovery of new therapeutics effective against unculturable pathogens. Commercialization of one or more of these therapies could result in saving the US $3 billion or more in annual economic losses caused by unculturable plant pathogens.

Breeding and Genetics of Landscape Roses Adapted to a Humid Subtropical Climate

Project Director

Oscar Riera-Lizarazu

Organization

Texas A&M University

Accession Number

1023882

Breeding and Genetics of Landscape Roses Adapted to a Humid Subtropical Climate

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

Since consumer and industry surveys suggest that heat and disease tolerance are the most desired traits in landscape roses, the Texas A&M University (TAMU) rose breeding and genetics program has focused efforts to better understand the genetic basis of adaptation, to use this information in a variety development context, and to implement/develop genomics-based tools/approaches to address these issues. The major challenges are to bring together resistance against fungal diseases (black spot and Cercospora leaf spot), resistance to rose rosette disease (RRD), heat tolerance, and high ornamental quality.

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

We have made major inroads in establishing a genomic-based analytical pipeline to discover genetic determinants of resistance to black spot, Cercospora leaf spot, rose rosette disease, and various traits of ornamental value. A pipeline to use genotype-by-sequencing (GBS) technology for the construction of comprehensive linkage maps in diploid and tetraploid roses was established. In turn, this capability has been used to identify quantitative trait locus/loci (QTL) using various populations. QTL for resistance to black spot, Cerscopora, and RRD have been identified using inter-related diploid rose populations as well as tetraploid populations. Studies in both diploid and tetraploid populations have also revealed QTL for flower productivity and plant architectural traits. The identification of genetic determinants that control these traits and associated marker haplotypes has allowed the identification of marker-tagged trait donors and has helped design more optimal strategies to manipulate these traits in a variety improvement context. The goal is to combine conventional and leading-edge approaches in the development of germplasm with better disease resistance and adaptation.

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

Rose growers, the rose industry, gardeners in Texas, and others in areas with similar environments benefit from our activities through germplasm/variety releases and related information developed by the program. Information is distributed via seminars, presentations, and talks at various industry meetings, online outlets, Agrilife Extension, TAMU Agricultural Communications as well as through commercial partners.

The rose breeding and genetics research community benefits from our activities through the availability of scientific and technical information on rose genetics and breeding. This information is distributed via referred scientific papers, communications at national/international scientific meetings, and articles in the popular press.

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

In 2014, rose growers produced ~37 million garden roses worth $203 million but only ~25 million bushes worth $168 million in 2019. This reduction in productivity is, in large part, due to the damage caused by fungal diseases and a viral disease known as Rose Rosette Disease (RRD). About 35% of garden roses, that are sold, are used by the landscape market, but this sector has decreased their use of roses by ~10% each year due to RRD. The estimated loss of rose sales due to the RRD epidemic is estimated to be $10 million/year. Our research to understand the genetic basis of disease resistance and adaptation that is translated into landscape rose germplasm with better fungal and viral disease resistance, as well as better adaptation, will contribute to reducing these losses. Also, professional surveys have shown that heat and disease tolerance are the most desired traits in garden roses among consumers and the industry. Thus, our efforts will also contribute to better product value to the market.

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

Plan of work:

We will develop populations to identify additional sources of rose rosette disease (RRD) resistance. We will continue with efforts to combine the major partial black spot resistance factor on linkage group (LG) 3 and the black spot resistance genes *Rdr1* (LG1), *Rdr3* (LG6), and *Rdr4* (LG5). Besides gene stacking efforts, we will continue work to better understand the genetic structure of rose breeding germplasm and to identify/characterize other genetic determinants of disease resistance (black spot, Cercospora, and rose rosette disease), flower productivity, and ornamental value. Once key QTL have been better characterized and validated, these will be added to our gene pyramiding/breeding effort.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Rose Rosette Disease (RRD) is a viral disease that is the greatest threat to the rose industry in the U.S. We have discovered genes in rose that can reduce RRD severity by 20 to 30%. Since the estimated loss of rose sales due to RRD is $10 million annually, deployment and adoption of varieties with the resistance that we have identified could potentially reduce these losses by $2 to 3 million/yr. The economic impact of adopting RRD-resistant rose cultivars is estimated to be at least $35.7 million per year.

Improving Rice Disease Management Practices

Project Director

Xingen Zhou

Organization

Texas A&M University

Accession Number

1022598

Improving Rice Disease Management Practices

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

Rice diseases are among the most important factors limiting the profitable and sustainable production of rice. Kernel smut, a disease once considered a minor disease, has become a major disease in rice in recent years. Seedling diseases, sheath blight, and narrow brown leaf spot (NBLS) continue to be the major diseases in Texas and other rice-producing states. This project addresses seedling disease, sheath blight, NBLS, and kernel smut and develop the practices to impove the managment of these diseases.

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

1) Improve seedling disease management strategies by better understanding the pathogen populations or causal agents involved, screening germplasm for resistance, and developing effective chemical and biological seed treatment methods.

A referred journal article summarizing the survey results of fungal pathogens causing rice seedling diseases in the southern United States (Texas, Louisiana, Arkansas, Mississippi, and Missouri) was prepared and accepted for publication. These survey results help understand the major causes of seeding diseases in dry seeding production systems in the southern United States.

A field trial was conducted at Beaumont, Texas in 2021 to evaluate four fungicide seed treatments, including Vibrance, Dynatsy, Spirato, Apron, Maximum, for control of *Rhizoctonia solani* causing seedling disease, stand improvement and yield increase. The results demonstrated the effectiveness of Vibrance seed treatment under the Texas environments. In addition, a field trial was also conducted at Beaumont, Texas in 2021 to determine the performance of five seed treatments with biocontrol agents on rice plant growth improvement and seedling disease suppression. Two biocontrol agents were identified to be effective for management of seedling diseases in rice.

2) Improve kernel smut management practices by developing a reliable greenhouse inoculation method, screening for resistance germplasm, and identifying effective fungicides and optimum fungicide application timings for main and ratoon crops.

Two separate greenhouse tests, one at Beaumont and the other at College Station, were conducted to verify the effects of inoculation methods (spray vs. injection) on the incidence of rice kernel smut. Although the results were inconsistent, it seemed that the injection inoculation method produced a higher level of infection than the spray method, which was similar to the last year's results. However, additional tests are still needed to find a more effective inoculation method.

A field trial was conducted at Beaumont, TX to validate the efficacy of optimum timing of fungicide applications for control of rice kernel smut in main and ratoon crops. Amistar Top applied at the mid-boot stage was more effective in reducing kernel smut than applied at mid-boot + 14 days. Therefore, the mid-boot stage is the best time to apply a fungicide for control of rice kernel smut. However, under most conducive weather conditions like 2021, two applications, one at the mid-boot stage followed by 2nd application at heading, were needed to provide sufficient control of rice kernel smut.

3) Optimize sheath blight and NBLS management practices by screening for resistant germplasm and effective fungicides.

A disease nursery was established at Beaumont and Eagle Lake in Texas in 2021 to continue evaluating the response of rice cultivars or elite breeding lines to sheath blight and NBLS under Texas environments. The Beaumont site evaluated a total of 65 entries, consisting of 28 inbred and 37 hybrid cultivars and lines from the Texas Rice Inbred Breeding Program, and 39 hybrid breeding lines from the Texas Rice Inbred and Hybrid Breeding Programs,, respectively. The Eagle Lake site evaluated a total of 277 entries, consisting of 237 from the Uniform Regional Rice Nursery (URRN) and 40 hybrid breeding lines from the Texas Hybrid Breeding Program. No cultivars or breeding lines had an immune reaction or extremely high levels of resistance to sheath blight. Most of cultivars and lines were rated susceptible or very susceptible to sheath blight. Several inbred lines and most hybrid lines were observed to have partial resistance to sheath blight . Most cultivars and elite breeding lines, especially hybrids, had immune reaction or higher levels of resistance to NBLS. These results will assist rice inbred and hybrid breeders in developing new cultivars with improved resistance to sheath blight and/or NBLS.

A field trial was conducted at Eagle Lake, Texas to evaluate the efficacy of eight fungicide treatments for control of sheath blight and NBLS. Two new fungicides, Amistar Top and Excalia, and one new generic fungicide, Aframe, were among the best fungicides in reducing sheath blight and NBLS.

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

Major results and findings of this project have been disseminated to rice producers, rice millers, crop consultants, county extension agents, chemical industry representatives, extensional specialists and the general public through a variety of outreach activities. These activities include two talks and three research abstracts for the 2021 Rice Field Days at Beaumont and Eagle Lake, Texas; seven oral and poster presentations at local, state, and national extension and outreach meetings; and 12 farm visits. My research and outreach activities will provide practical tools and management recommendations for farmers to combat rice diseases and maximize production returns. Major outcomes and impacts from this project were:

1. Co-released Trinity, a new rice variety, with more than 13% yield improvement over Presidio and good tolerance to common diseases, including sheath blight and brown spot. This new variety will provide an excellent addition of the variety pool to the Texas rice industry.

2. Demonstrated for the first time by multi-genes sequencing that there present at least three genetically different populations of the rice kernel smut pathogen in the United States. This new information will assist rice breeding program in developing rice varieties with an improvement resistance to kernel smut.

3. Discovered two new fungal pathogens, *Rhizoctonia solani* AG4 and *Marasiminus graminum*, which can cause seedling diseases in rice. Both pathogens are more virulent than the common seedling disease pathogens, posing a threat to rice production.

4. Understood, for the first time, the distribution and importance of major fungal pathogens associated with seedling diseases and their population genetic diversity and evolution across the southern rice-growing states. The results of this research have significantly advanced our understanding of the etiology and epidemiology of rice seedling diseases in the United States, which can provide the foundation to develop improved fungicide seed treatments to minimize stand loss caused by seedling diseases.

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

Results of this project were delivered to national and international scientific communities and public through the 2021 American Phytopathology Society's Virtual Annual Meeting, and the 2021 US Rice Breeders' Annual Meeting, and through article publications in professional and scientific journals (nine research papers).

The methods and findings resulted from this project can also be applicable and adapted to be used for management of rice diseases in rice production systems in other countries. To the end, my research and outreach activities could help reduce the losses caused by diseases and increase rice production at a global scale to feed the world's half population.

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

NA

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Seedling diseases, sheath blight, and kernel smut are among the most important disease and insect pests causing an estimate of 25 to 41% of global yield losses in rice, the leading food crop feeding more than half of the world population. Texas A&M AgriLife Research's Rice Plant Pathology Research Project addresses these disease issues, especially kernel smut, a newly emerging disease in the U.S. and has developed an effective research and extension program that improves the management practices for these diseases. Seedling disease surveys in the southern U.S. have led to the discovery of two new pathogens (Rhizoctonia solani AG4 and Marasiminus gramimum) and the understanding, for the first time, of distribution and importance of major fungal pathogens associated with seedling diseases and their population genetic diversity. Kernel smut surveys demonstrate the presence of at least three genetically different populations in the U.S. Germplasm resistance screenings have successfully identified several genotypes with high levels of resistance to these three diseases. These findings have been assisting breeders in developing rice cultivars with improved resistance against multiple diseases. Effective

fungicide treatments and optimum application timing have been identified and widely adopted by growers for control of these diseases. Early planting and proper N fertilization (< 180 lb N/A) are among the best agronomical management practices identified that can reduce the damage caused by sheath blight and kernel smut. These results and findings have been delivered to stakeholders via field days, grower meetings, workshops, social media, factsheets, publications, and other outreach activities to sustain and enhance rice production. Application of these improved disease management practices can reduce 50% of yield loss caused by these diseases and increase annual revenue of the Texas rice industry by $9.5 million and the U.S. rice industry by 138 million.

Development of Gene-Based Breeding (GBB) for Crops of Agricultural Importance

Project Director
Hongbin Zhang
Organization
Texas A&M University
Accession Number
1022603

Results

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

It is essential to continue genetic improvement of crops and development of superior varieties to feed the increasing global population; however, the genetic gain of crop improvement with the current breeding methods has been stagnated or slightly increased in staple food crops such as wheat, rice, corn, and soybean, which cannot meet the food demand for the increasing population. This project aims to develop a revolutionary and extremely powerful and efficient breeding system in crops of agricultural importance in the USA, designed gene-based breeding (GBB), that develops superior varieties by design according to breeding objectives, based on genes controlling the traits through the entire breeding process, including parent selection, cross design, and progeny selection. Studies have shown that GBB can potentially further improve current best varieties by 73% - 118%, thus promising to promote the next green revolution and help feed the world.

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

Genes are the core of crop genetic improvement, and their favorable or heterotic alleles are essential for development of varieties that are high-yielding, high-quality, and resistant to diseases and adverse environmental stresses. We previously invented a novel technology, defined as the *gExpress* technology, for high throughput cloning of genes controlling agronomic traits, cloned over 9,000 genes controlling corn grain yield and yield and quality traits and over 10,000 genes controlling cotton fiber yield and quality traits, invented GBB, and tested the utility and efficiency of the cloned genes for enhanced crop breeding through GBB. Therefore, we conducted the following research activities in the past fiscal year:

1. **Development of a GBB system for inbred line and hybrid variety breeding in corn.** Over 95% of the corn grown in the U.S. are hybrid varieties. Development of hybrid varieties consists of two steps: development of elite inbred lines and development of hybrid varieties from the developed inbred lines. Therefore, we first developed a GBB system for inbred line grain yield breeding and then developed a GBB system for hybrid variety grain yield breeding from inbred lines using a corn inbred line population and two hybrid breeding populations, respectively. Because most agronomic traits, such as yield, quality, and resistance to disease, pest, drought, high temperature, etc., are controlled by numerous genes, three types of genic data were collected and used for development of the GBBs, including the total numbers of favorable or heterotic alleles, genic DNA biomarkers, and/or expression activities of the genes controlling the inbred line yield and hybrid grain yield, respectively. We found that progeny selection for superior inbred lines or hybrids using these data of the genes controlling grain yields could accurately (100%) select for the same top 10% inbred lines or hybrids as those selected by the current replicated field variety testing.

Furthermore, as the GBB systems were developed using only a single inbred line breeding population derived from a biparental cross and two hybrid breeding populations developed from the inbred line breeding population, additional research is needed to test whether the GBB systems could generally be used for enhanced breeding with diverse inbred line populations and diverse hybrid breeding populations. Therefore, we started an experiment to test and optimize the GBB

systems into those efficient for GBB with diverse inbred line populations and diverse hybrid populations nationwide. We obtained the USDA corn inbred line mini-core collection consisting of 305 diverse inbred lines representing the gene pool of U.S. public breeding programs and 51 recently expired protested variety plant (PVP) diverse inbred lines representing the gene pool of U.S. private breeding programs. In the FY 2021, we conducted the second-season field trials in College Station for the inbred lines and a selection of their 300 hybrids and collected grain yield and 19 grain yield and quality traits. We also collected the genic data of the genes controlling inbred line grain yield and hybrid grain yield, respectively. The genic and phenotypic data are currently under analysis to optimize the GBB systems for corn inbred line and hybrid variety breeding.

1. **Development of a GBB system for fiber quality breeding in cotton**. Cotton is the world's leading crop for natural fibers and oilseeds. USA is the third largest cotton producer worldwide and cotton is the fourth largest row crop, only after corn, wheat, and soybean. As those done for corn, we also developed a GBB system for fiber breeding in cotton using a cotton breeding population derived from a bi-parental cross. Like the results achieved in corn, the performance of cotton fiber traits could accurately be predicted using the number of favorable alleles, genic DNA biomarkers, and expression activities of the genes controlling the fiber trait, separately or jointly, confirming that GBB can be used for cotton fiber breeding. Furthermore, we examined the potential of the GBB for cotton improvement using the genes controlling cotton fiber length that we previously cloned. We found that the current best cotton cultivars can further be improved by 74% - 118% through GBB, revealing the potential of GBB for continued crop genetic improvement.

Furthermore, we were conducting GBB using a new breeding population developed by the Texas A&M AgriLife Research Cotton Improvement Laboratory, College Station, Texas, with two objectives: 1) independently further test the GBB system using a different breeding population and 2) develop a high-throughput and affordable genotyping pipeline with genes controlling the breeding objective traits for GBB in cotton. This experiment is currently still on-going. Moreover, we are also optimizing the cotton GBB system using breeding lines and released cultivars for GBB in cotton nationwide. The breeding lines and cultivars have been identified for this experiment.

1. **Development of a GBB system for enhanced breeding in wheat.** Wheat is one of the three largest food crops, including corn, rice, and wheat. Given the potentials of GBB for continued crop genetic improvement and the success of GBB development in corn and cotton, we initiated development of a GBB system for wheat. We collected 172 varieties and 28 superior breeding lines representing the U.S. hard winter wheat, especially those grown in the Great Plains, and phenotypes of a number of their agronomic traits, including grain yield, across TX, CO, KS, OK, and IA. A research proposal was developed and submitted for research funding to genome-wide clone the genes controlling grain yield using the *gExpress* technology that we invented and develop a GBB system for enhanced wheat genetic improvement.

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

Gene-based breeding (GBB) is a revolutionarily new breeding technology that breeds for superior varieties by design according to breeding objectives, based on genes controlling objective traits, particularly their number of favorable alleles (NFAs), their genic DNA biomarkers, and/or their expression activities. Because GBB allows accurate selection of breeding parents that are the most desirable to approach breeding objectives, wise designing of parent cross to achieve the most desirable combinations of the favorable and heterotic alleles of the genes controlling objective traits into progeny, and earlier and accurate selection of superior individuals from the progeny and develop them into new varieties competitive for production, it can improve the ability and efficiency of the current breeding methods by hundreds of fold. Because genes are the core determinants of superior varieties and a variety having the best gene content can perform best in an optimal environment, GBB can be performed in an industrialized manner, such as in phytotron, greenhouse, or an off-season, differing from the current field-based breeding. Therefore, GBB can shorten current breeding cycle by 3 – 5 years, thus dramatically accelerating the current breeding process and increasing genetic gain per unit time. Moreover, the hundred-fold increased efficiency, the industrialized breeding practice, and dramatically reduced field work of GBB further reduce the breeding cost by numerous folds.

Therefore, development of GBB systems for major crops, such as corn, cotton, and wheat, will allow breeders to develop and provide superior cultivars by design for agriculture production continuously, efficiently, rapidly, and cost-efficiently, thus helping feed the increasing population and secure the world's food supplies. Studies showed that the current best cultivars can further be improved by 74% - 118% through GBB.

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

Broader public will greatly benefit from this project activities by increased and cost-efficient food and fiber production and supply through utilization of improved cultivars developed by means of the GBB systems developed from the project activities. Particularly, the following benefits will be achieved:

- The world's production of corn, wheat, and cotton were 1,108 million tons (2019), 766 million tons (2019), and 121 million tons (2019), valuing at $188 billon, 123 billion, and 72 billion, respectively. If the new cultivars developed by the developed GBB systems increase yield of these crops by 10%, additional $38.3 billion crop income will be obtained worldwide.

- The technology and methodology developed and used in these project activities in corn, cotton, and wheat are applicable to all crop species and livestock. Therefore, the benefit of these research activities can be further multiplied by developing GBB in other crop species and livestock.

- The *gExpress* technology used in these project activities can genome-wide high-throughput clone genes controlling complex traits from any species, including plants, animals, humans, and microbes, regardless of genome size, complexity, ploidy level, and availability of molecular or genomic knowledge. Therefore, the technology can also be used for genome-wide cloning of the genes controlling human diseases. The genes cloned genome-wide can be used to develop gene-based health, gene-based clinics, and gene-based medicine, thus revolutionizing the current phenotype-based medicine, and promoting a pleasant, healthy, and long life for humans.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Development and use of elite varieties that are of high yield, high quality, and resistance to diseases and environmental stresses is one of the most efficient approaches to increase agricultural productivity and famer's incomes. Genes are the core determinants of performance of all elite varieties. The gene-based breeding (GBB) recently invented is a revolutionary plant and animal breeding technology that develops superior varieties by design according to breeding objectives, based on genes controlling objective traits through entire breeding process, including parent selection, cross design, and progeny selection. The hatch project has cloned most genes controlling corn grain yield and quality traits and cotton fiber yield and quality traits and developed GBB in corn and cotton - the largest and fourth largest crops in the United States. Studies have shown that GBB can potentially further improve current best varieties by up to 118%, thus markedly improving agricultural productivity and increasing farmers' incomes. Based on the values of the corn current $61 billion and cotton current $5.6 billion annual farm outputs in the U.S., the U.S. corn and cotton farmers' annual incomes will increase by $6.1 billion and $0.56 billion, respectively, if the new breeding technology is used to improve their varieties by 10%. Importantly, GBB is applicable to all crops, vegetables, fruit trees, and livestock. If GBB improves the current varieties of these crops and livestock by 10%, the U.S. farmers' annual incomes will increase by more than $13 billion, according to their 2020's $135 billon farm output value

Agricultural practices to enhance soil quality and resource efficiency in the Texas Southern High Plains

Project Director
Katie Lewis
Organization
Texas A&M University
Accession Number
1022362

Carbon, nitrogen and water impacted by conservation management in semi-arid region

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

Conventional tillage and intensive monoculture crop production coupled with an ever increasing demand for water has led to areas with diminishing soil health and decreasing water resources. Inevitably, the Texas High Plains region will have to accommodate less irrigated land and more deficit irrigated and dryland farming; however, enhancing soil health will likely optimize inputs and maximize nutrient and water use efficiencies possibly making dryland farming more profitable. Research is aimed at determining more feasible crop rotation, and soil and water management and fertilization strategies that maintain or enhance the value and health of soil and optimize water and nutrient use efficiency all the while ensuring the economic viability of farming operations.

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

Across the High Plains of Texas, research is being conducted to address the following objectives: 1) Determine the optimum application timing and rate of nitrogen fertilizer for continuous cotton and cotton rotated with wheat and following a cover crop under varying irrigation levels; 2) Evaluate cropping systems of cotton rotated with wheat compared to continuous cotton and determine effects of management strategies, such as tillage and irrigation level on soil health; 3) Demonstrate and quantify the impact of no-tillage and single and mixed species cover crops on soil C and soil water holding capacity, yield and economics of cotton production; and, 4) Identify and quantify the effects of soil health promoting practices (no-tillage, cover crops and crop rotations) in organic and conventional cropping systems. To address the above objectives, soil samples and greenhouse gas measurements are collected to determine environmental impacts of cropping system decisions, and agronomic data is assessed to evaluate the ecnomics of the systems.

To address objectives 1-3, research locations have been established near Halfway and Lamesa, TX. The systems at these locations evaluate the interactive effects of cropping management (rotation, cover crop and tillage) and irrigation capacity. The longer term systems have allowed for determining rates of soil carbon capture and storage across multiple growing environments and soil textures. While soil carbon is increasing due to conservation management practices, the rate of increase is slow becase of the semi-arid environment. Generally, there has been no benefit to lint yield or ecnomics when using cover crops; however, crop rotation has a positive impact on both economic and environmental sustainability.

To address objective 4, organic and conventional research is being conducted in the High Plains and Rolling Plains of Texas on university farms. 2021 completed third year of organic research at these locations, and we are currently summarizing the economics of the systems. Preliminary results have been summarzied regarding the enviornmental aspects of the project, which indicate that conservation managment has a more beneficial effect on soil health parameters than organic production.

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

Soil carbon information of cropping systems collected across the High Plains has been instrumental to our Texas stakeholders. This information has provided guidance to expected carbon sequestration outcomes across varying soil textures and environmental conductions. Our stakeholders are using this information when making decisions on conservation managment practices aimed at carbon programs being promoted across the United States. The data being collected has been presented across the state and even to grower groups in nearby states interested in carbon markets.

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

Conservation management in semi-arid environments has a much broader impact related to reduced soil erosion. With a greater number of acres implementing reduced tillage, cover cropping or crop rotations, less soil is being eroded and less of the broad public is being negatively impacted by dust storms.

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

Results are made available through reports and presentations. The data being collected has been presented across the state and even to grower groups in nearby states interested in carbon markets. Lobbying groups and politicians have also been present during these presentations. Results are also being shared at scientific meetings. Sharing of information whether it be at stakeholder or scientific meetings, has lead to new collaborations and research opportunities. Projects are on-going and will be managed to accomplish established goals.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Soil carbon information collected across Texas High Plains cropping systems has been instrumental to our Texas stakeholders. Our results have demonstrated a greater potential to sequester carbon in irrigated cropping systems producing greater biomass in heavier textured soils. In a harsher environment (sandy soil and deficit irrigation), research has demonstrated the potential to sequester on average 0.14 ton carbon/acre annually to a 36 inch depth when using no-tillage and a rye cover crop following cotton harvest. At this rate of carbon accumulation, there is the potential for irrigated cotton cropping systems using no-tillage and a winter rye or wheat cover crop to sequester approximately 230,000 ton carbon annually across the Texas High

Plains. This information has provided guidance to expected carbon sequestration outcomes across varying soil textures and environmental conductions. Our stakeholders are using this information when making decisions on conservation management practices aimed at carbon programs. Through increased carbon storage and subsequently improved soil health, there should be less wind erosion of soil which will positively impact the broader public.

Closing Out (end date 09/07/2023)

Plant Genetic Resources Conservation and Utilization

Project Director

John Cason

Organization

Texas A&M University

Accession Number

1022430

Wild Species Peanut Introgression Program

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

In our pre-breeding program, we utilize a wild peanut collection to introgress genes into cultivated breeding lines that can be used in the peanut breeding programs around the globe to improve the cultivated peanut. We evaluate wild species for traits of interest. Once an attribute is identified genes must be moved along what has been termed an introgression pathway. This involves developing complex hybrids that are cross-compatible with a species of section Arachis, searching until the hybrid can be crossed with a cultivated peanut line. Using this technique we have transferred genes for leafspot, rust, root-knot nematode, pod rot and tomato spotted wilt virus resistance into breeding lines and cultivars adapted to Texas. As genomics, bioinformatics and high throughput phenotyping have become less expensive, we strive to use them to learn basic genetic information of the cultivated peanut and its wild relatives. In addition, we endeavor to employ these new technologies to introduce traits into cultivars from the wild peanut relatives.

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

Project personnel continued exploring the development of new introgression pathways by conducting 7 wide cross wild species hybridizations to explore the genetic compatibility of various sections of Arachis. These efforts center on finding new combinations of species that can be used to move genes of interst into the cultivated peanut. We are also continuing our efforts to specifcally develop a drought tolerance introgresion pathways by conducting 5 wild species crosses with a total of about 50 pollinations. We also conducted a transcriptomics study invovling 2 species and a total of 3 accessions in an effort to validate findings of a previous study. In addition, to this research we also conducted 120 wild species increases regenerations many of which are not found in the NPGS collection. A portion of the increase if supplied to the national Arachis collection.

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

The primary audience for this project during this reporting period is other scientist and the general scientific community. We presented research and paticipated in regularly scheduled scientific meetings of the American Peanut Research and Education Society Meetings and as part of that participated in the Arachis Crop Germplasm Committee meetings, We also published an article on the identification of drought stress using Raman Spectroscopy for the general scientific community.

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

Peanut (Arachis hypogaea L.) is a very nutrious food that has been found to be heart healthy and is also a good source of protien. However, peanut is geneticall isolated from a chromosome doubling event that occurred in the past. Wild peanuts possess many beneficial traits that can be reintroduced to the cultivated peanut. Our concentrated effort to collect wild and exotic Arachis germplasm has been ongoing for over 50 years around the world. Our project currently houses seventy-six of the 83 species of Arachis at the Stephenville Texas A&M AgriLife REC and have made significant progress in utilizing both the cultivated and wild materials to expand the genetic base of the cultivated peanut to make the peanut even more nutritous and grown in a more sustainable and evironmentally friendly way.

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

New personnel have been put in place and we will strive to provide them with training to allow them to have success in their positions. This will include allowing them to attend Scientific conferences such as the American Peanut Research and Education Society Meetings. We also published results of a drought stress study conducted in our greenhouses in one peer review journal and an additional conferece poster on the use of Raman Spectroscopy for detection of drought stress.. Additionally project personnel published a new species decription for Arahcis inflata. We will continue our germplasm regeneration efforts inculding providing seed to the national collection in an effort to preserve the valuable germpaslm that in some cases is no longer available in its place of origin. We also continue to develop new introgression pathways that can be used to transfer genes of interst to the cultivted peanut including biotic and abiotic traits. A new area of interst is enhancing the nutritional content of peanut. Specifically looking for these desireable triats in wild germplasm as well as conducting research trials that give us a better understanding of the traits and genes found in wild species peanut.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Our project focuses on meeting the needs of peanut growers by development of new varieties using of wild species peanuts. Here in Texas peanut producers continually face issues of pest, disease and drought. For example, root-knot nematode damage can cause losses up to 90%. However, resistance from wild relatives imparts almost total immunity with no treatment required which represents a $48,000,000 annually savings for US growers as well as the added benefit the helping the environment. Our program developed the first root knot nematode resistant variety and continues to improve and release new higher yielding ones today. Similarly, our program continues to develop Sclerotinia minor resistant varieties, that can save producers up to $150/ac/year in fungicide applications. We have also recently identified several genes in wild species associated with drought tolerance that are native to an area of Brazil that gets less than 250 mm of precipitation per year.

We have also recently embarked on a project to increase the oil content of peanut for the renewable diesel industry. Currently, the primary limiting factor for a sustainable renewable diesel industry in the U.S. is the reliable supply of adequate quantities of economically priced vegetable oil feedstocks. Rudolph Diesel, the creator of the diesel engine is quotes at saying ““The diesel engine can be fed with vegetable oils and would help considerably in the development of agriculture of the countries which use it.” Today we stand on the cusp of that statement becoming reality. Peanuts powered the first diesel engine and have the potential to produce over 300 gallon of oil per acre which is much higher than the current industry standard of soybeans as 50 gallons per acre.

Finally, very soon humanity is facing a critical food shortage. In the next 50 years the earths increasing population growth will require new and innovative methods of variety development to feed an ever-growing number of people. Currently, peanut lacks 2 essential amino acids that are the building blocks of proteins. We are looking for the presence these amino acids in our wild species peanut collection. Once developed we will have a peanut that can be grown around the world and people will have access to this critically needed superfood.

Insect management for field crops: IPM tactic evaluation, area-wide approaches, and beneficial insect conservation

Project Director
Michael Brewer
Organization
Texas A&M University
Accession Number
1022390

Natural enemies, mediated by landscape and weather conditions, shape response of the sorghum agroecosystem of North America to the invasive aphid Melanaphis sorghi

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

The sorghum agroecosystem of North America provided an opportunity to evaluate agroecosystem response to the invasive *Melanaphis sorghi* (sorghum aphid) (previously published as *Melanaphis sacchari*) (Hemiptera: Aphididae) onto widely planted sorghum that experiences a range of agro-landscape and weather conditions. The rapid spread and damaging sorghum aphid outbreaks beginning in 2013 supported its characterization as a novel, invasive colonizer causing substantial ecological disruption and economic losses. The invasion onto sorghum occurred at a near-continental scale, where natural enemy activity, weather, agro-landscape conditions vary, which we hypothesized influences spatially variable sorghum loss caused by *M. sorghi*.

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

A large-region comparative study (three regions from the northcentral to southern Great Plains, and one southeastern U.S. region) *characterized the natural enemy complex, estimated M. sorghi and natural enemy population trends, and detected relationships of natural enemy activity on M. sorghi as mediated by agro-landscape and weather conditions. A proposed risk scenario brought* top-down forces of *M. sorghi*-natural enemy interactions to the forefront as mediated *by agro-landscape and weather conditions. This risk scenario* accounted for *natural enemy abundance and activity that was highest in the South region,* functioned well across agro-landscape and weather conditions *and was accompanied by average* low *M. sorghi* abundance (~23 *M. sorghi* per leaf). Positive correlations of natural enemy-*M. sorghi* abundance also occurred in the southern Great Plains region where *M. sorghi* abundance was low (~20 *M. sorghi* per leaf), and selected natural enemy activity appeared to be mediated by landscape composition. *Melanaphis sorghi* abundance was highest in the southeastern U.S. region (~136 aphids/leaf) where natural enemy activity was low and influenced by weather.

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

From a regional pest management perspective, this study adds to the evidence that parasitism and predation by resident natural enemies are well suited to aphid management in the low-input large-scale cereal agroecosystem of the North American Great Plains. For *M. sorghi*, sorghum growers are on average at low to modest risk from sugarcane aphid in the southern Great Plains, a region that was previously expected to be severely affected by this invasive aphid. In other regions, combining an agroecosystem service of parasitism and predation with use of sorghum resistant to *M. sorghi* that does not deter parasitism and predation is particularly important where risk is more persistent, variable, or prone to variable natural enemy activity as mediated by agro-landscape and weather conditions (e.g., southeastern U.S. and southcentral Great Plains regions). In such cases, variable top-down forces provided by natural enemies benefit from the addition of bottom-up forces of sorghum resistant to *M. sorghi*, as well as strategic use of insecticides with low toxicity to natural enemies.

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

The agroecological impact on a regional scale is significant: the risk scenario we developed was suited in assessing risk on a regional scale and understanding agroecosystem response to sugarcane aphid. The risk scenario appeared suited, and essential in the southern Great Plains region, in assessing risk and sets the stage for further modelling to generate estimates of degree of influence of varying agro-landscape and weather conditions. Broadly, these findings are relevant in understanding agroecosystem resilience and recommending supportive management inputs in response to insect invasions.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Best pest management practices have been developed in response to an invasion by a sorghum aphid pest (scientific name Melanaphis sorghi) that first appeared in Texas in 2013 and quickly spread across the Great Plains and other regions of North America within a few years. We now understand why this sorghum aphid poses a lowered risk to sorghum in several regions of the Great Plains compared with early outbreak years of the mid-2010s. Natural enemies native to the Great Plains (small wasps that parasitize the aphid and predators like lady bugs) are common across land-use and weather conditions seen in sorghum production areas, especially in the warm temperate and subtropical regions of Texas where sorghum was initially expected to be severely affected by this aphid. Although economic outbreaks occurred soon after the aphid invasion, natural enemy suppression of the aphid now commonly lowers aphid populations below economic concern. Our research working with sorghum producers supports that the lower Great Plains agroecosystem is resilient to aphid invasions, which aided the return to a sustainable pest management system based on natural enemies and supplemented with aphid targeted insecticides and planting partially aphid-resistant sorghum. Agricultural community stability has returned with the end result being little grain sorghum acreage reduction attributed to this aphid in the Great Plains. Environmental and economic benefits include insecticide use declining and grain loss from uncontrolled aphid outbreaks. Working from the basis of a

previous economic analysis, the improved control of this sorghum aphid equates to a direct annual grain revenue increase and insecticide cost savings of $24.4 million where about 350,00 acres of sorghum are grown in the subtropical sorghum production region of south Texas.

Enteric Diseases of Food Animals: Enhanced Prevention, Control and Food Safety

Project Director
Yuhua Farnell
Organization
Texas A&M University
Accession Number
1020986

Results

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

Salmonella causes foodborne illnesses in approximately 1.2 million people every year in the United States, which is a major concern for human health. *Salmonella* Typhimurium is one of the most common *Salmonella* serotypes in the United States, which causes gastrointestinal disease in humans. The contamination of poultry meats with *Salmonella* is a major source of this foodborne pathogen. Understanding the host-*Salmonella* interactions in chick will improve strategies to reduce the contamination of poultry products. There is a lack of long-term cultures of intestinal epithelial cells in chicken, and the development of in vitro cell culture model is needed.

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

1. Animal studies have been performed to study the role of extracellular vesicles in serum of broilers after *Salmonella infection*. The major molecules inside of extracellular vesicles are microRNA (miRNA), which is non-coding RNAs with 18-25 nucleotides in length and play important roles in regulating target genes. We found that serum miRNA profiles in *Salmonella-infected broilers* had significantly different profiles from those in control group using small RNA sequencing technology. Seventeen miRNAs upregulated and 12 miRNAs downregulated in the *Salmonella-infected* birds compared to the control birds ($P < 0.05$). Bioinformatic analysis indicates that these miRNAs targeted genes that are involved in modulating humoral, innate, and adaptive immune responses, cytokine-mediated signaling pathway, B cell proliferation and differentiation, activating nature killer cells and T cells, positive regulation of peptidyl-serine phosphorylation of STAT protein, and Notch signaling pathway ($P<0.05$).

2. We have successfully developed three-dimensional organoids from chicken intestine (long-term storage).

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

1. More research scientists in poultry field will study cell-derived extracellular vesicles and understand the function of extracellular vesicles in poultry disease progression.

2. The development and establishment of a long-term 3-D organoids (enteroids) provide the tools for scientists in the poultry field to study nutrient supplementary and host-pathogen interactions.

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

1. MicroRNA found in serum extracellular vesicles could be served as immune-modulators and may provide an opportunity to reduce the contamination of poultry products.

2. The organoid model (ex vivo) will reduce the use of animal studies by saving billions of dollars for animal testing. This platform can be used for drug and supplementary screening, including nutrient supplementary, immunomodulator and antibiotic alternatives.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Avian intestinal organoid biobank was established, which will help reduce the numbers of animals used, implementing the principles of the 3Rs- replacement, refinement, and reduction for the use of animals in experiments.

Critical Issue

Community and Economic Development (1862)

Advancing Human Resources for Food, Agriculture, Natural Resources, and Human (FANH) Sciences: Identification of Barriers and the Development of Enablers

Project Director

Theresa Murphey

Organization

Texas A&M University

Accession Number

1024488

Results

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

The need for prepared individuals to work across agricultural industries continues to grow. My project seeks to address this need through identification of barriers and opportunities connected to accelerating learning for targeted populations and the creation of curriculum to meet these needs.

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

The major activities I have completed over the past year focused on research related to teaching and learning (i. e, motivation of university students, best practices for curriculum development) and the creation of curriculum for university and high school students. I have contributed to the creation of multiple modules of instruction related to decision-making skills for high school students and curriculum for university students focused on bringing about awareness to roles that women play in development.

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

In regard to our gender-lensed curricula, we have hosted multiple seminars which highlight the content shared in the modules. University faculty across the nation are able to access the modules as we create them for use in their classrooms. We have met directly with high school teachers via interview and focus group sessions to better understand the format and delivery attributes desired for the modules to be used in the high school classroom. Teachers were complimentary of the content covered in the modules and look forward to using the modules once they are accessible.

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

The broader public will ultimately benefit from my work via prepared members of society whether that be via a college graduate or a high school graduate. The material that I focus on in the curriculum that I am involved in developing focused on soft skills (decision making and communication) along with content to sensitize them to societal issues specifically related to women in development. The curriculum developed is targeted to encourage critical thinking skills and thus result in individuals who are able to contribute to agricultural industries.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The need for prepared individuals to work across agricultural industries continues to grow. My project seeks to address this need through identification of barriers and opportunities connected to accelerating learning for targeted populations and the creation of curriculum to meet these needs. We have created curriculum for university and high school students while documenting best practices for curriculum development. This curriculum has focused on instruction related to decision-making skills for high school students and curriculum for university students focused on bringing about awareness to roles that women play in development. The curriculum developed is targeted to encourage critical thinking skills and thus result in individuals who are able to contribute to agricultural industries.

Analysis of Economic, Socio-Demographic and Market Factors Impacting Consumer Demand for Food and Beverage Products

Project Director

Oral Capps

Organization

Texas A&M University

Accession Number

1022744

Consumer Demand Analysis for Food/Beverage Products

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

The availability, accessibility, and choice of foods to meet an adequate and safe diet and to promote health and nutrition have been and continue to be fundamental challenges facing the U.S. food distribution system. Understanding the factors influencing food choices, including economic, social, psychological, and physiological factors, allows us to understand the mechanisms by which individuals/households select, purchase, and consume foods. Knowledge about how people make food choices, what factors influence consumer demands for food, the economics of farm-to-retail distribution of food, and changing food markets is critically important to develop effective agricultural and food policies.

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

The activities associated with this research are relevant to agribusiness, consumer economics and food marketing, including but not limited to: (1) understanding drivers of demand for food products; (2) catering to the time-starved consumer; (3) catering to the health-conscious consumer; (4) ascertaining the effectiveness of advertising and promotion as well as spillover effects for commodity organizations; (5) identifying the determinants of price spreads or marketing margins; (6) understanding consumption patterns of selected socio-demographic groups; (7) understanding the structure of the processing, wholesaling, retailing, and food service sectors; (8) investigating the impacts associated with product recalls; (9) calculating plate waste of food and beverages served on school lunches; and (10) assessing the damages if any associated with the mislabeling of food products.

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

To date, results have been provided to USDA, Agricultural Marketing Service, USDA, Economic Research Service, the Food and Nutrition Service, and to the SOuthwest Dairy and SOuthland Dairy Farmers. As well, this research has led to positive interactions with various agricultural commodity organizations such as the American Pecan Council, Cotton Incorporated, and the Mexican Hass Avocado Importer Association.

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

The major deliverables include developing and expanding alternative methodologies to estimate the relationships among economic forces, demographic factors, consumer information, health and nutrition, and other factors on the consumption of food and beverage products and to assess the importance of forces on the demand for food and consumption behavior. Bottom line, the set of research ideas and their operationalization associated with this project ultimately will translate into increased benefits, both tangible and intangible, to various stakeholders of the food industry, policy analysts, and academicians relative to the increased costs incurred in carrying out the work.

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

No major changes or problems have been encountered thus far with this research project.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

On behalf of the Agricultural Marketing Service (AMS), the Dairy Research and Promotion Program and the Fluid Milk Processor Promotion Program, otherwise known as the National Programs, were evaluated with two key questions in mind: (1) Have the demand-enhancing activities conducted by dairy producers, importers, and fluid milk processors increased the demand for fluid milk and manufactured dairy products? (2) Did those who have paid for the promotions conducted benefit from them? Using state-of-the art econometric and simulation analysis, the overall benefit-cost ratio (BCR) of the dairy promotion program was calculated to be 4.76. That is, for every $1 spent on demand-enhancing activities, dairy producers received an additional $4.76. The BCR for fluid milk promotion was calculated to be $3.26 for every dollar invested in demand-enhancing activities. For cheese promotion, the BCR was calculated to be $3.62 per dollar invested in cheese promotion and $24.40 for every dollar invested in butter promotion. The BCR for dairy export promotion was calculated to be $6.94 per dollar invested. The National Programs promotion spending also enhanced dairy production and prices. The promotion increased the annual average number of dairy cows by 0.34 million head, milk production by an annual average of 7.58 billion pounds, and the U.S. all milk price by an annual average of $1.13 per cwt. Class III and Class IV milk prices were higher by annual averages of 4.0 percent and 22.1 percent, respectively.

Funded by the Healthy Eating Research Imitative through Duke University and the Robert Wood Johnson Foundation, research was done to identify and assess macroeconomic factors, particularly economic, financial, and sociological stressors, associated with the COVID-19 pandemic, linked to participation the Supplemental Nutrition Assistance Program (SNAP), the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and the National School Lunch Program (NSLP). These programs not only provide targeted populations access to food, a healthy diet, and nutrition education but also serve as a safety net and protection against income losses and unexpected expenses.

Different sets of macroeconomic drivers which affect the respective food assistance programs were evident. No macroeconomic factor was common across SNAP, WIC, and NSLP participation. As well, changes in macroeconomic conditions which influence SNAP, WIC and NSLP participation were not only contemporaneous but also affected participation levels anywhere from 1 month to 12 months later.

This work confirmed that the impacts associated with the Kansas City Financial Stress Index; the St. Louis Financial Stress Index; the number of initial claims for unemployment insurance; the unemployment rate; and the ratio of total consumer credit outstanding to disposable personal income were positively related to the level of participation in the SNAP, WIC, and NSLP. Further, this research substantiated that the impacts associated with manufacturers' new orders of durable goods; real disposable personal income; real M2 money stock; housing starts; and the University of Michigan Consumer Sentiment Index were negatively related to the level of participation in the SNAP, WIC, and NSLP.

From this research, the Food and Nutrition Service (FNS) will be in better position not only to assess program needs and costs but also to forecast program participation levels to minimize errors in the budgetary process. As well, because the impact of COVID-19 on level of participation in SNAP, WIC, and the NSLP was measured statistically, FNS staff and analysts now possess knowledge that was heretofore lacking to help them better prepare for future pandemics or other major shocks to the economy.

Studies have been conducted in the extant literature dealing with the fortification of reduced-fat cheddar cheese with n-3 fatty acids, processed cheese fortified with fish oil emulsion, selected cheeses fortified with vegetable and animal sources of omega-3 fatty acids and the fortification of processed cheese spread with omega-3 fatty acids. But no studies currently exist that deal with the economic feasibility of the fortification of processed cheese. This ex-ante analysis considered simulated market demand and supply conditions to evaluate the percentage increase in the demand for processed cheese needed to offset the incremental costs of fortification to maintain producer profitability. With only minimal shifts in the demand for processed cheese, it was demonstrated that fortification with omega-3 fatty acids can occur without any loss in producer profits. This finding supports the contention that fortification of processed cheese indeed is economically feasible for

manufacturers. The additional important by-products for manufacturers in doing so are the diversification of their product line and the provision of a healthier product to consumers. In addition, the potential increases in the demand for processed cheese due to the fortification with omega-3 fatty acids also are beneficial to dairy farmers, to retailers, and to consumers.

Research was conducted to study the economic effectiveness of American Pecan Council (APC) activities and expenditures on generic pecan advertising and promotion activities. The study concluded that the APC has effectively enhanced domestic and export demand for U.S. pecans over 2016/17 through 2019/20 through its generic promotion activities and generated a relatively high rate of return to pecan producers. The principal accomplishment of the APC domestic and export promotion program has been to support the annual average producer price of pecans about 24¢/lb (11%) above the level to which it might have fallen over the period of 2016/17 through 2019/20 if the promotion had not been done. Given APC promotion expenditures, excluding administrative costs, the benefit-cost ratio for the APC promotion program for 2016/17 through 2019/20 was calculated at 9.9, meaning that the promotion returned $9.9 in profit to pecan producers for every dollar spent on promotion. Importantly, this study found that the APC promotion program can take credit for supporting the producer price of pecans by about 11% and saving producers $275.4 million (about 12%) in profit that would have been lost without the promotion, a remarkable achievement with rather modest promotion funds over a short period of time.

Funded by the Cotton Board, research was conducted to study the economic effectiveness of the cotton checkoff program. The study concluded that the cotton checkoff program enhanced cotton and cottonseed demand, augmented U.S. cotton yields and production as well as cottonseed prices, generated a positive return to both cotton producers and importers, reduced the dependence of cotton producers on government farm programs, and benefited taxpayers. In particular, the study noted that over the period 1986/87 to 2019/20, the cotton checkoff program returned $6.40 per dollar invested in cotton promotion and accounted for 8.8% of the net revenue earned by cotton producers. The cotton checkoff program also returned $17.40 in after-tax profit per dollar of investment to retail cotton fiber importers and accounted for 11.2% of U.S. retail cotton product revenue since 1992/93.

Additionally, due to investment in agricultural research, the checkoff program reduced costs per acre planted of upland cotton, primarily for fertilizer, chemicals, fuel, and custom operations. The cost savings specifically from the investment of checkoff dollars in agricultural research were $7.60 per acre planted on average, ranging from $4.67 per acre to $11.72. The per acre savings to cotton producers from cotton checkoff investments in agricultural research amounted to 4.56% of the average cash costs of chemicals, fertilizer, custom operations, and fuel.

Critical Issue

Connecting Agriculture and Health (1862)

Evaluation of Food, Agricultural and Biological Materials for Improved Characterization and Value-Added Utilization

Project Director
Elena Castell-Perez
Organization
Texas A&M University
Accession Number
1025957

Characterization of nanoencapsulates to increase health benefits and safety of fresh produce

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

The research activities carried out demonstrate the potential to use cheaper, natural encapsulation materials for controlled release of nutrients (antioxidants) and antimicrobials for improved food health and safety. These functional materials will help enhance the health of consumers while extending shelf life of perishable products such as leafy greens.

PVA nanocomposite films were synthesized and embedded with synthesized nanoparticle. Physical and mechanical properties of the films and antimicrobial activity showed potential for use in packaging of leafy greens.

New knowledge was generated on stability and effectiveness of Zeolitic Imidazolate Framework (ZIF-8) nanoparticles for use as effective antimicrobials that could replace chlorine.

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

Some natural compounds have tremendous antioxidant (health benefit) and antimicrobial (food safety benefit) capabilities and embedding them into commonly used polymeric food packaging materials using nanotechnology has the potential to increase safety of minimaly processed fresh produce. Our research has focused on the antimicrobial capabilities of trans-cynnamaldehyde and other essential oils but we are planning to characterize the potential of diverse materials including metal-based frameworks such as ZIF-8. Zeolitic Imidazolate Framework (ZIF-8) nanoparticles work as a drug carrier of natural antimicrobials such as *trans-cinnamaldehyde* (TC). Embedding the ZIF-8@TC nanoparticles in polymeric materials creates an active food packaging film. Characterization of the capabilities and functionality of the complexes helps to understand how these active materials release from the films and interact with the foods. PVA-composite films were effective as antimicrobial packages of spinach leaves.

Current research is focusing on finding feasible ways to reduce microbial contaminaion of leafy greens from harvest to distribution at the retail level.

Feasibility for this project includes economics of food waste and losses as well as consumption of water and energy in the leafy greens supply chain. Emphasis is on pathogenic microorganisms such as Liseria, salmonella and Escherichia coli.

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

Graduate students got training on engineering appraoches to food contamination with pathogens, microbiological testing, food quality and shelf life studies and nanotechnology applications to increase health benefits of foods. The new knowledge generated will help guide future research objectives in terms of testing of new antimicrobials and new polymeric materials.

Food industry personnel and scientists had access to publications from our findings.

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

Feasible methods to prevent and/or reduce pathogen contamination in fresh produce will lead to fewer foodborne illness outbreaks and consecuently, fewer deaths due to consumption of minimally processed foods like fresh produce.

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

The only challenge we encountered was the slowing down of research activities due to COVID-19 safety protocoles.

Six graduate students were trained on relevant food technology and engineering approaches to increase product shelf life and safety. Findings were disseminated at the Institute of Food Tecnologists (IFT) Annual Meeting in the form of poster presentations. Additionally, findings have been published in peer-reviewed scientific journals.

One issue we will address next period is the potential toxicity of several metal-based complexes and determination of safe concentrations for use in food products.

Another issue we will investigate is the feasibility of using biodegradable polymers in antimicrobial food packaging.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

On average, it takes about 540 years for a PET water bottle to biodegrade and about 50 years for a plastic bag. As the food packaging industry tries to reduce the impact of plastic packaging on the environment, research on biodegradable packaging using natural polymers has increased.

Fresh produce and packaged foods are highly susceptible to contamination and spoilage when improperly packaged. The active films made from poly-vinyl alcohol (PVA) with embedded nanoparticles containing natural antimicrobials improve the safety of highly perishable foods such as leafy greens sold in bags.

The PVA-nanocomposite antimicrobial films are a suitable alternative to commercial low-density polyethylene (LDPE) packaging commonly used in leafy greens bags and may reduce the use of chlorine as a sanitizer in fresh produce processing chains.

Implementation of biodegradable antimicrobial packaging can reduce the risk of foodborne disease outbreaks due to the consumption of contaminated fresh produce and help reduce produce waste due to recalls.

Research on other natural polymers (proteins from plants or insects and polysaccharides) will help develop reliable, robust and environmentally friendly food packaging alternatives to plastic.

Evaluation of a Civic Engagement Approach to Catalyze Built Environment Change and Promote Healthy Eating and Physical Activity Among Rural Residents

Project Director
Rebecca Seguin-Fowler
Organization
Texas A&M University
Accession Number
1022517

Result

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

Both of the projects focus on health disparities among at-risk populations: the CO-CSA study focuses on food access and food insecurity among low-income caregivers and their children, and includes a behavioral and economic intervention for families, support for local farmers to help rural economies, and development of undergraduate and graduate-level education modules related to food systems and obesity prevention. The Change Club study focuses on residents with at least one cardiovascular disease risk factor who reside in medically underserved rural communities, and community-level evidence-based intervention strategies to make healthy eating and/or physical activity more accessible; the Change Club is a civic engagement intervention for built environment change to improve health behaviors and outcomes for residents of rural communities. Change Club members engage in nutrition and physical activity lessons and stepwise planning for built environment change; change in cardiovascular disease risk factors will be evaluated in Change Club members, their friends and family members, and other community residents and compared to community residents in control communities.

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

Key activities of the CO-CSA project this year have included publishing six peer-reviewed articles, with two more in review, plus forthcoming analyses for two additional articles, as well as dissemination of the short-course modules and lectures for undergraduate and graduate students. These articles detailed the results of our objectives to examine the CO-CSA's effect on the children and caregivers' dietary and physical activity behaviors (e.g., 'Community supported agriculture plus nutrition education improves skills, self-efficacy, and eating behaviors among low-income caregivers but not their children: a randomized controlled trial,' published in the International Journal of Behavioral Nutrition and Physical Activity); knowledge, attitudes, and behaviors related to nutrition, meal planning, and preparation; contrasting CSA models (e.g., 'Models for cost-offset community supported agriculture programs,' published in the Journal of Agriculture, Food Systems, and Community Development); evaluating the economic impact of a CO-CSA program (e.g., 'Cost effectiveness of a subsidized community supported agriculture intervention for low-income families,' oral presentation at the Society of Behavioral Medicine's annual conference); and evaluating options for farmers to sustain the CO-CSA. For the Change Club, the core activities have included modifying our protocols and data collection activities to be responsive to the ongoing covid-19 pandemic. For example, we pivoted to a lab contract for data collection versus conducting health fairs; added additional communities to achieve recruitment goals; and created a more flexible and dynamic intervention delivery plan to accommodate hybrid, in-person, and remote delivery. We expect to relaunch the trial in April 2022.

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

For the CO-CSA project, we have produced reports and tool kits with community partners, including extension educators and farmers. For the Change Club, we have worked closely with community partners and the research team to make the study intervention as well as materials and data collection requirements more appropriate given covid-19.

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

For the CO-CSA project, we have prepared publications and presentations for many audiences and updated information on our websites. For example, we delivered the keynote address at the Junior Master Gardener National Leader Training Conference. We are applying the lessons learned from the CO-CSA project to a new intervention with home delivery produce boxes paired with tailored education for low-income families. For the Change Club, we are not yet at the stage of the project that public benefit is relevant; however, we are planning to share a publication in the upcoming year that will detail how data collection and community engagement was adapted to meet local needs.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Farm Fresh Foods for Healthy Kids (F3HK) was a five-year integrated research, extension, and education project (PI: Seguin-Fowler, Rebecca), in which more than 300 low-income families with children enrolled to receive a community supported agriculture (CSA) share where the grant funds paid half the cost and the family paid the other half of the cost, often using SNAP benefits. The 12 participating farms across four states received funds and technical support to establish SNAP-EBT for payment. The intervention was a randomized controlled trial, and results demonstrated significant improvements in dietary skills and intake (e.g., increase of 1/3 cup daily of fruits and vegetables) among low-income caregivers with children as well as improvement in household food security. Four food systems education modules for faculty/instructor use were informed by the study and are available nationally. There have been 31 published peer-reviewed articles from this study. Dr. Seguin-Fowler and study team members have delivered 28 talks on study findings to national audiences; most recently Dr. Seguin-Fowler spoke to an audience of 100+ attendees from 15 states across the U.S., at a meeting hosted in College Station regarding critical future directions for this area of research, evaluation, and practice.

Critical Issue

Health and Wellness (1862)

Improving the health span of aging adults through diet and physical activity.

Project Director

Yuxiang Sun

Organization

Texas A&M University

Accession Number

1022678

Results

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

Low-grade chronic inflammation, coined as “Inflamm-aging”, is a hallmark of aging closely related to aging lifespan and healthspan. Macrophages, the body’s “gate keepers” of immunity, undergo dynamic changes during aging and are very relevant to pathogenesis of inflamm-aging. Our project aims to identify a strategy to reprogram macrophage polarization thus combat inflamm-aging to improve lifespan/healthspan.

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

Aging is often accompanied by obesity, and obesity promotes chronic inflammation. Chronic inflammation is prevalent in aging, which is linked to a wide range of age-related diseases such as diabetes, cardiovascular disease, and cancer. A major mediator of inflammation is a type of immune cells, called macrophages. Aging tissues have increased pro-inflammatory macrophages, which releases harmful factors to the circulation and into the tissue environment causing tissue damage.

Ghrelin is a gut hormone which functions through growth hormone secretagogue receptor (GHS-R). GHS-R is present in macrophages, and its levels in macrophages increase under obesity and aging. We reported that deletion of GHS-R protects against age-associated obesity and inflammation. **We hypothesize that GHS-R is important in control of macrophage function during aging, and GHS-R inhibition mitigates age-associated inflammation, improving overall health.** To study the function of GHS-R in macrophages, we generated a unique mouse model with GHS-R deleted selectively in macrophages. We will subject these mice to regular diet or high-fat diet (HFD) to mimic normal aging and aging obesity, respectively.

We anticipate that GHS-R is a crucial factor in macrophage reprogramming during aging, affecting lifespan and healthspan. The "proof-of-concept" studies in this proposal will provide critical evidence as to whether GHS-R blockade represents a unique strategy for combating aging and age-related diseases.

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

Scientists, trainees, aging public, elderly with chronic diseases.

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

We know many factors affect inflammation, such as diet, excise, stress, environmental pollutions etc. and many of these factors affect ghrelin – Ghsr pathway that execrates inflamm-aging. Having the knowledge of our study, the general public can be motivated to reduce those pro-inflammatory risk factors in their lives, which will help them to be more resilient to diseases, thus improving the quality of life.

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

What was accomplished under these goals?

Chronic inflammation is a major pathology for aging which affects a wide range of tissues, termed "inflamm-aging". Aging correlates with increased obesity and insulin resistance, which is known to associated with low-grade chronic inflammation in both central and peripheral tissues. Ghrelin receptor - Growth Hormone Secretagogue Receptor (GHS-R) is increasingly recognized to have important roles in metabolism and inflammation. We found that GHS-R has a critical role in inflammation of aging mice, GHS-R activates metabolic pathways to reprogram macrophage polarization toward a pro-inflammatory state, subsequently eliciting meta-inflammation in adipose tissues, liver and brain.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Chronic low-grade inflammation is a major pathology of aging, affecting both central and peripheral tissues, which is now coined as "inflamm-aging". Aging is correlated with increased obesity and insulin resistance that are associated with low-grade chronic inflammation. Ghrelin is an important nutrient-sensing hormone that functions through its receptor, Growth Hormone Secretagogue Receptor (GHS-R). We found that GHS-R expression is increased in many tissues of aged mice, and positively-correlated with inflammation signatures. Our study further revealed that GHS-R is expressed in macrophages, and GHS-R reprograms macrophage polarization. Macrophages are a major immune cell type controlling inflammation, are “gate keepers” of the body. Using state-of-art gene knockout models, we showed that GHS-R deletion in macrophages attenuates inflammation in both central and peripheral tissues in aging, mitigates age-associated obesity, insulin resistance, and severe inflammation such as sepsis.

Our novel data collectively demonstrate that: 1) GHS-R is an important regulator of macrophages and has a major role in inflamm-aging; 2) Ghrelin signaling is a critical link between nutrient sensing and immunity pathways. Our findings suggest that suppressing GHS-R in macrophages may provide an exciting new strategy to combat inflamm-aging and age-associated diseases, thus increasing healthspan.

Natural Resources and the Environment (1862)

Land use and management practice impacts on soil carbon and associated agroecosystems services

Project Director
Asko Noormets
Organization
Texas A&M University
Accession Number
1023560

Results

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

Soil health and soil carbon content have been declining as the result of intensive management, physical disturbance. This project aims to quantify the effects of different management activities on processes that regulate soil carbon balance.

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

Soil health, the multidimensional framework providing structure and resources for different organisms to coexist and buffering environmental extremes, is the foundation of sustained biological and economic productivity, cornerstone of livelihoods, and a critical element for human health. A key indicator of soil health is its carbon content that facilitates aggregate formation, structural stability, water and nutrient retention, and functional complexity (NRCS 2018b). Therefore, land use practices and management techniques are being re-evaluated as per their effect on this critical ecosystem property. The world's ecosystems are increasingly seen as an important component in addressing the challenge of climate change (United Nations 2015), and mitigating the rise in atmospheric carbon dioxide concentration. Terrestrial biosphere cycles about 15.7% of the atmospheric carbon each year (or all of it in 6.4 years), with roughly equal amounts being assimilated through photosynthesis and released through respiration. The climate benefits can arise if more of the assimilated carbon enters long turnover pools than is released from them, either in vegetation or in soil. However, the expansion of human land use continues to erode the area of carbon-rich old-growth forests (FAO 2012) and a growing fraction are managed (Hansen et al. 2013) at increasing intensity (Fox et al. 2007). The intensifying use of not only forests, but all ecosystems, has likely negative connotations for biological carbon sequestration for two (biological) reasons. First, ecosystem management typically involves the replacement of ecosystems with high standing biomass and moderate productivity with those with low standing biomass and high productivity. As the result, human land use has doubled the carbon turnover rate compared to natural undisturbed systems (Erb et al. 2016). Second, the increasing disturbance frequency that accompanies intensive land management stimulates heterotrophic activity, and the mineralization of existing soil C pools (Lewis and Wheeler 2019, Noormets et al. 2015). As soil carbon pool is a good indicator of potential ecosystem productivity and because its buildup is slower, protecting it should be the highest priority when evaluating sustainable management alternatives. Furthermore, as human extraction of primary production is certain to continue, and restoring high standing biomass ecosystems is unlikely, the prospects for biological carbon sequestration rely on protecting and increasing the soil carbon pool (Schlesinger and Amundson 2019). As agricultural cultivation techniques are being revised to reduce soil carbon cost of these activities and mitigate the damage caused by excessive ploughing (Baker et al. 2007, Lu et al. 2009, van Groenigen et al. 2011), the appreciation of the impact of management activities on forest soils is lagging behind compared to traditional agricultural crops. This is particularly true for prescribed burns that have been implemented for other important considerations - prevention of wildfires, prevention of the spread of pests and pathogens, creation or maintenance of wildlife habitat, and competition control in timber plantations (Kalies and Kent 2016). While the consumption of surface fuels is most obvious, the effects of fire on belowground processes, and subsequent responses in productivity are not always appreciated (Homann et al. 2011). This is, at least partly, attributable to the fact that prescribed fires are deliberately timed for sub-optimal conditions to maintain control over the spread and intensity of fire, and the consumption of fuels is incomplete. While high-severity wildfire can consume over 90% of aboveground detritus and over 20% of soil C (Erickson and White 2008), prescribed burns are much gentler by design (Homann et al. 2011). Nevertheless, the rapid evaporation of water in soil pores during fire has been shown to exert strong enough physical force to disrupt the bonds between soil aggregates (Albalasmeh et al. 2013) that explains the deterioration of soil structure even under relatively low intensity burns (Urbanek 2013). Thus, fire can degrade the essential properties of soil productivity - its structure, carbon content, water- and nutrient holding capacity. The effect on microbial communities is less clear, it appears that microbes generally recover rapidly (e.g., Catalanotti et al. 2018, Kranz and Whitman 2019, Sadeghifar et

al. 2020, Wang et al. 2012), except under excessively high fire frequency (Williams et al. 2012). However, quantifying changes in soil carbon pools remains a challenge because of the high spatial variability of this pool, and requires either a very large sample size or a long sampling interval. Therefore, belowground carbon dynamics remain a significant uncertainty in ecosystem and Earth System Models (De Kauwe et al. 2014, Friedlingstein et al. 1999). It is only through national scale and multidecadal repeat soil surveys that have been able to identify changes in soil carbon pools (Bellamy et al. 2005, Don et al. 2011, Maia et al. 2010, Xie et al. 2007, Yan et al. 2011). Smaller scale studies that use this methodology invariably fail to detect a change in soil C pools, as the spatial variability of soil C content exceeds the small temporal trends. In contrast, flux-based assessments of soil carbon balance can identify consistent trends at annual scale (Noormets et al. 2015). This approach has lower spatial variability due to spatial averaging across the fine-scale heterogeneity. As one line of inquiry, the current study will measure soil carbon balance as the difference between soil carbon inputs (above and belowground detritus production) and losses (soil heterotrophic respiration) as described earlier (Noormets et al. 2012). Although the rates of change in soil carbon pools are small in relation to total pool size, they have been detected globally (Bellamy et al. 2005, Don et al. 2011, Maia et al. 2010, Xie et al. 2007, Yan et al. 2011) and confirmed through different independent approaches (Crowther et al. 2016, Davidson 2016). The magnitude of the losses and the significance of the trends have been greatest in soils with the greatest initial C stock, especially in organic soils. The losses are partly attributable to warming (Bond-Lamberty and Thomson 2010), partly to management (Noormets et al. 2015), the signature feature of which - physical soil disturbance - is the most likely cause the increase in heterotrophic fraction of soil CO2 efflux (Bond-Lamberty et al. 2018). Given that the heterotrophic respiration pulse that follows harvest and other site disturbance can last from about a third to the entire harvest cycle in mid-latitude plantations (Bracho et al. 2018, McElligott et al. 2016), the reduced mean stand age and lower overall C pool size (aboveground biomass, belowground biomass and soil C all are reduced by about 50%), the disproportionality of heterotrophic respiration in the overall carbon budget is particularly noticeable (Noormets et al. 2015). Based on the flux balance approach, and analyzing about 3500 site-years of data, we showed that soil carbon imbalance in the world's forests is widespread, and that soil C loss is about twice greater in managed than unmanaged forests (200 vs 100 g C m-2 yr-1; Noormets et al. 2015). Carbon deficit in fire-managed forests is likely greater, and is the subject of the current study.

Methods

Soil carbon balance (DSOC) can be estimated as the difference of carbon inputs and losses over a period of time (e.g. a year): where detritus production (Di) from litterfall (DL), fine root mortality (DFR), coarse woody matter (DCW), branchfall (DBF), and coarse root mortality (DCR), can be offset by lateral transport of said components (T), leached out of soil profile (L) or consumed by soil organisms (Rh). On annual timescale and in the absence of major disturbances, DCW, DCR, T and L are usually negligible; DBF is also usually very small in young aggrading stands. The main inputs of carbon to soil are the short-lived tissues of foliage and fine roots, and the primary process of C loss is microbial respiration. Soil carbon balance as assessed as the difference between these fluxes.

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

The expected user base for these products includes all different land owner types - federal and large state landowners, timber industrial landowners, and small non-business landowners. For example, the rapid stemwood growth and high economic productivity of loblolly pine have made it the industry favorite for the past 70 years (Fox et al., 2007). The concurrent decline in longleaf and shortleaf pine have led to initiatives in USDA Forest Service to restore these species, with the guiding principle being habitat requirements for a number of endangered and game species. The current project will provide information about soil carbon consequences of different species selection and management approaches like prescribed burning, species selection, fertilization, herbicide use and mechanical treatments.

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

The project will produce a series of peer-reviewed publications, conference presentations, and PhD dissertations, presenting the current state and management effects, including prescribed burning, species selection, competition control and fertilization, on soil carbon balance and storage in the forests of the Southeastern United States. The results from the work will be provided to land management decision support tools (DSS; including Texas Forest Service's ELMER next generation DSS).

Expected Outcomes

The work offers a new way of validating existing ecosystem models, identifying remaining observational uncertainties, and overall provide a new level of insight into the functioning and carbon sequestration potential of forest and non-forest ecosystems. Defining the quantitative trade-offs between the economic productivity of forests and the carbon balance of soil will incorporating these costs and benefits to explicit optimization models, and allow land managers explicitly define their management objectives, direct and indirect (carbon) costs, and inform decisions about species selection and management practices.

Participants

Role	FTE-s for this reporting period
Faculty	0.2
Students	
Undergreaduate	0.5
Graduate	1
Post-doctorate	0
Total	1.7

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Biological carbon sequestration in ecosystems is seen to hold great potential for climate mitigation. However, many projects target only high productivity, with limited attention to decomposition and the allocation of carbon to pools with different residence times which determine the retention of assimilated carbon. My team has developed a conceptual model to estimate belowground carbon allocation in plants, and the efficiency of biomass production using commonly used but rarely co-deployed measurements of ecosystem carbon fluxes. It also allows the estimation of otherwise unmeasurable carbon fluxes like non-structural or storage carbohydrates, exudation and allocation to rhizosymbionts. To date, this model has been successfully tested on a chronosequence of loblolly pine production forests, and it captures age-related differences in carbon allocation to aboveground growth, belowground growth, and storage carbohydrates, contrasting respiratory costs of biomass production and different drought thresholds. Biological carbon sequestration can be effectively deployed as a climate mitigation tool only when carbon allocation to different tissues, carbon input pathways to soil and their decomposition pathways are quantitatively understood. Our carbon allocation model provides a powerful and unique assessment tool for one of the major global challenges of this century.

Closing Out (end date 09/07/2023)

Plant Genetic Resources Conservation and Utilization

Project Director
Jeff Brady
Organization
Texas A&M University
Accession Number
1023402

Results

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

The project focuses on sustainable solutions for cultivation of peanut, targeting reduced water usage through a better understanding of transcriptional responses to drought, and through association with endophytic microbes that increase peanut's ability to withstand dry periods

then recover when precipitation occurs. Additionally, the project supports collection, description, and inoculation testing of microbes that alter competitive relationships between an invasive grass species, KR bluestem, and native grasses such as little bluestem.

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

In 2021 there were personnel recruited and hired to further project activities. In January of 2021 Kelly Carroll was hired as a master's level graduate student at Tarleton State University to characterize differences in little bluestem and KR bluestem microbiomes as a thesis topic. They were instrumental in making statewide collections of KR bluestem and little bluestem from 35 Texas counties spanning the state, including permitted collections from 11 state parks. There are now a total of 743 samples from roots, leaves, and soil associated with the two grasses. 511 of those samples have had 16S and ITS sequencing libraries created and sequenced, and the remainder of the libraries are in-progress with an expected shipment date to the TAMU sequencing center in mid-April, 2022.

Simultaneous with the collection and microbiome characterization of the two grasses, a collection of microbial endophytes was created from little bluestem and placed in long-term -80? storage by 3 Tarleton State University undergraduate student researchers hired in 2021. The strain collection numbers almost 300 microbes, and is composed of roughly 60% bacterial species and 40% fungal species. The student researchers have begun screening the microbial strain collection for negative impacts on KR bluestem and simultaneous neutral or positive impacts on little bluestem. Two culturable endophytic bacteria have been identified with the desired characteristics. Screening additional microbes from the strain collection will continue throughout 2022.

In June of2021 a postdoctoral bioinformatics research associate, Dr. Olabiyi Obayomi, was recruited and hired to work on project activities for 50% of his duties. He has facilitated microbiome analysis for the KR bluestem/little bluestem microbiome comparison noted above. Additionally, he is analyzing a little bluestem accession RADSeq study and a peanut drought stress transcriptome study. The peanut drought study produced an average of 63 million reads per sample and just over 3 billion reads for the whole set of 48 samples. The dataset was too large to analyze locally, and Dr.. Obayomi is conducting the analysis on TAMU high performance research computing resources. We have prepared sequencing libraries for horticulturally important Indiangrass (a native species) cultivars to compare transcriptomic differences associated with leaf color variation. We anticipate receiving that sequence data in the next two months.

Several grants were submitted in 2021 related to project goals and objectives. A Smith Fellowship for conservation biology was submitted and declined in 2021 in an effort to fund a field postdoctoral research associate for native/invasive grass microbiome work. Three small successful grants (altogether totaling $20K) were written and funded in 2021 in collaboration with the TSU graduate student to help fund their activities. A proposal was submitted to the Chevron corporation in 2021 to further develop "Diesel Nut" peanuts as a biofuel to be grown in marginal dryland regions of the southern U.S. The proposal was accepted, and will fund a Ph.D. student working on this program to identify endophytic microbes providing increased resistance to biotic and abiotic stresses, particularly water stress, enabling cultivation of diesel nut peanuts on marginal dryland areas. A directed collection strategy was employed in 2021 by Tarleton State University undergraduate researchers who have initiated the peanut endophyte strain collection for this new project, which now includes about 150 culturable peanut endophytes that have been placed in long-term -80? storage. Activities for screening the endophyte collection will begin in the fall of 2022 with the arrival of the Ph.D. student. Recruitment of that position is now underway.

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

Information about project activities was disseminated through several presentations this year, including a presentation to the Native Plant Society of Texas, a presentation to the Chalk Mountain Wildlife Management Association, and a presentation for the Tarleton State University President's Excellence in Research Scholars program. There were individual meetings with Dr. Tony Falk of the Texas Native Seeds Program, and with Dr. John Cason, peanut breeder at Texas A&M AgriLife Research to communicate about progress with ongoing collaborative projects and for grant writing strategy sessions for 5 grants submitted in 2021.

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

Efforts to restore native grasslands in Texas are hampered by invasive grass species, particularly KR bluestem [*Bothriochloa ischaemum* var. *songarica* (Rupr. ex Fisch. & C.A. Mey.)]. KR bluestem has replaced little bluestem and other native grasses on hundreds of thousands of hectares in the southern grasslands of North America and is gradually adapting to colder, drier climates further north and west. This project develops positive and negative plant-soil feedbacks as a novel management tactic to augment or replace existing methods (grazing, burning, mechanical disruption, herbicides, reseeding, etc.) that are sometimes successful, but often fail in long-term restoration of native grasslands. Prolific and rapid seed production by the invasive grass necessitates repeated herbicide applications over the course of about 18 months or the invasive seed bed germinates and outcompetes reseeded native grasses. Rain events during the 18 fallow months not followed by herbicide application effectively reset the restoration effort back to square one. New and sustainable management tools applicable on a large scale that target germination of invasive KR bluestem are needed to facilitate grassland restoration efforts so that native grasses will not be outcompeted during establishment. This project is identifying microbes that will serve as germination biocontrols for KR bluestem, providing a novel management tactic for controlling KR bluestem germination, greatly facilitating the efforts of native grassland conservation. This work will support the broader public by facilitating the restoration of degraded grasslands in the southern U.S. and will help stem the tide of ongoing biodiversity loss associated with those grasslands.

Peanut research associated with this program supports the broader public by increasing water use efficiency and by creating and/or expanding energy markets for peanut as a biofuel crop. Water use efficiency is targeted through the plant genome and through interactions between the plant and associated microbial species that increase drought tolerance so that productivity can be maintained even with intermittent drought. Given that the majority of peanut in Texas is produced on the high plains and currently requires irrigation from Ogallala aquifer resources, any decrease in water use serves to conserve that resource into the future. Similarly, bioenergy peanuts offset a portion of fossil fuel consumption, decreasing the liberation of long-term carbon stores that impact the broader public through climate change.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

KR bluestem is an invasive grass from China that is taking over roadsides and grasslands throughout the southern portion of the U.S. from the east coast to the west coast. It spreads widely and rapidly from seeds, crowding out native plants. The resulting KR bluestem monocultures support very few native species, leading to declines in insects, birds, and mammals. Prolific seed production limits control by herbicides, burning, disking, and grazing. Costs for restoring native grassland exceed $150 per acre and often result in a return to KR bluestem monoculture within 1 year. Members of the Brady Laboratory have isolated microbes from the native plant little bluestem that perform biocontrol functions, inhibiting germination and growth of KR bluestem seeds. When combined with conventional control treatments, microbial biocontrol may provide the first sustainable large-scale restoration tactic for grasslands degraded by KR bluestem.

Addressing the Changing Face of Agricultural Economics Research

Project Director

James Mjelde

Organization
Texas A&M University
Accession Number
1023451

Addressing rural transit, education, and crude oil

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

This project's goals are to address problems that receive less research funding and attention in agricultural economics departments. Receiving less attention does not lessen the importance of these problems, especially to clientele impacted in these areas.

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

Goals were achieved for this reporting period through conducting and analyzing surveys, analyzing spot market data, and education data. Given the differences in areas benefits are diverse.

- Texas rural transit districts were surveyed concerning how the districts coped with both the Covid-19 pandemic (concentrating on older adult riders) and the 2021 Snowpocalypse.

- Using survey data, a methodology was developed to provide information on the value of preserving Globally Important Agricultural Systems

- Using data from College of Agricultural and Life Sciences at Texas A&M, differences in grading between academic departments were found. Grade point averages (GPA) are used as differentiating factor among students, but grade inflation may distort the ability of GPAs to distinguish students as they move into the labor market.

- Potential differences in trading between U.S. crude oil spot markets are analyzed using spot market price data. Fracking and global economic conditions have caused changes in the quantity and quality of crude oil in various regions of the U.S.

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

- Results of the Texas rural transit district survey indicates incorporating rural transit districts into disaster and pandemic planning increases rural area's resiliency and ability to respond to disasters and pandemics lessening the effect of these events on rural populations and communities. Older adult riders where especially vulnerable suggested increased attention to these riders maybe necessary.

- Implications are clear for the preservation of agricultural heritage sites, developing programs to increase local residents' knowledge and support of sustainable development will increase their willingness to pay for preservation of such sites. Findings provide researchers and practitioners with important implications when they implement sustainable development of agricultural heritage resources.

- Knowledge of possible grade inflation among departments is important to reevaluate and design and implement effective grading policies.

- Changes in the energy sector have brought about changes in price differentials needed for crude oil to be traded between regions. Such changes impact crude oil prices; therefore, prices of crude oil products. Such knowledge can

improve the efficiency of the U.S. crude oil sector.

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

- General public especially rural older adults will benefit if rural transit districts are incorporated into plans to cope with disasters. Rural transit districts have specialized knowledge and capital resources to lessen the impacts of disasters.

- Proper preservation of agricultural heritage sites benefits society by the provisioning of ecosystem services to the local area and improving worldwide sustainable agriculture.

- Knowledge of possible grade inflation and determining departments that may be responsible for grade inflation is important to employers as they strive to hire the best candidates.

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

Presented Papers / Presentations

Dinhobl, M. S. Fasanando, R. Dudensing, and J.W. Mjelde. 2021. "The Impact of COVID-19 on Texas Rural Transit Districts with Emphasis on Their Older Adult Riders." Presented at North American Meetings of the Regional Science Association International. November 8-13, Denver CO. First authorship shared by Dinhobl and Fasanando.

Dinhobl, M. S. Fasanando, R. Dudensing, and J.W. Mjelde. 2021. "Snowpocalypse and the Response of Rural Transit Districts." Presented at TRB 24th National Conference on Rural Public and Intercity Bus Transportation. October 25-27, 2021. First authorship shared by Dinhobl and Fasanando.

Yeritsyan, A. and J.W. Mjelde. 2021. "Is there a Need for Grading Reform? Differences in Grading Patterns between Departments in the College of Agriculture and Life Sciences at Texas A&M." Presented at the 2021 AAEA & WAEA Joint Annual Meeting. Austin, TX. August 1-3, 2021.

Refereed Journal Articles

Park, Y.N., C.K. Lee, J.W. Mjelde, and Y.J. Kwon. "Policy Implications of Willingness to Pay Sustainable Development of a World Site: The Role of Stakeholders Sustainable, Support, and Behavioral Intention." Accepted *Sustainable Development*. 2021.

Duangnate, K., and J.W. Mjelde. "Impact of Changes in Global Environment on Price Differentials between the U.S. Crude Oil Spot Markets for the Periods Pre- and Post- 2008/09." *Journal of Energy Markets*. 14,3 (2021):

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

Rural Transit Impact Statement

Rural transit districts provide transportation for older adults and other transportation disadvantaged populations for everyday trips. One, however, often does not think about rural transit for these populations until they are in the situation of providing such services because of the inadequate nature of rural transit. Further, in the last two years Texas rural transit districts faced challenges beyond what they normally confront in the form of the COVID-19 pandemic and 2021 Snowpocalypse. A survey of Texas rural transit districts revealed how the districts coped with both the pandemic and Snopocalypse. Districts responded in a variety of unique ways to provide for their clients through these events. Older adult riders where especially vulnerable, suggesting increased attention to these riders maybe necessary. Incorporating rural transit districts, with their specialized knowledge and capital resources, into disaster and pandemic planning increases rural area's resiliency and ability to respond to such events.

GPA Impact Statement

A student's grade point average (GPA) is used by employers and graduate schools to distinguish between candidates. With grade inflation, increases in grades over time that do not reflect changes in the quality of student's performance, GPAs lose their ability to distinguish students. Results from using a unique dataset spanning 1985 to 2019 of student, instructor, and institution characteristics suggest increased student abilities and recruiting more female students have led to an overall (considering all departments together) increase in GPAs within COALS. After controlling for the above factors, grade inflation, however, has occurred, but such inflation varies by department. Knowledge of possible grade inflation and determining departments that may be responsible for grade inflation is important to employers and graduate schools as they strive to hire and enroll the best candidates.

A closed-loop dairy system by an integrated anaerobic digestion and pyrolysis process for food-energy-water nexus

Project Director
Eun Sung Kan
Organization
Texas A&M University
Accession Number
1018814

A closed-loop dairy system by an integrated anaerobic digestion and pyrolysis process for food-energy-water nexus

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

Dairy farms, like other animal farms, have multiple threats against sustainable operation such as significant pollution in water, air and soil, food safety, water shortage and energy supply. Current management of dairy manure such as land application often causes significant water, air and soil pollution. Thus, this project aims at development of integrated anaerobic digestion and pyrolysis process for enhancing environmental, agricultural and energy sustainability at dairy farms.

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

l. The novel functionalized and activated biochar produces were made from agricultural waste (waste hay, sawdust) for recovery of nutrients and removal of chemical and biological contaminants in water and soil. The metal-coated biochar (surface-functionalized biochar) and iron-activated biochar (activated biochar, similar to activated carbon) were produced via one step of pyrolysis/functionalization or pyrolysis/activation under the selected conditions.
2. The metal-coated biochar (MCB) possessed highly porous structure and metal oxides at the surface of MCB. The MCB showed high adsorption capacities for nutrients and antibiotics and moderate removal of microbial pathogens in water. The MCB was also applied to soil and crop systems for enhancing water quality and soil health while boosting microbial diversity for effective bioremediation.
3. The iron-activated biochar (IAB) possessed high surface area and carbon contents with various iron oxides at the surface of IAB. These unique properties of IAB supported high adsorption of antibiotics, BPA and algal toxins as well as high removal of microbial pathogens via multiple mechanisms.
4. Advanced anaerobic digestion of dairy manure at dairy farms: 1) The waste hay-derived biochar was added to the anaerobic digestion (AD) of dairy manure for enhancing biomethne production and manure digestion efficiency. It also showed cleaner effluent containing high fertilizer values. Besides, the mechanical refining of dairy manure was also investigated. The complete anlaylsis of biogas, biomethane, volatile acid compositions and various water quality were conducted. The results indicated higher biogas/biomethane production with the mechanically refined dairy manure.
5. Treatment of dairy effluent by the MCB and the IAB: The MCB and IAB were applied to real dairy effluent (from the 2nd lagoon effluent at Southwest Dairy Center, Stephenville, TX) to see thier capacities for recovery of nutrients and removal of contaminants from the dairy effluent. The MCB showed much higher recovery of phosphorus from the dairy effluent than other biochar and commercial activated carbon. The IAB showed excellent removal of antibiotics and organic contaminants in the dairy effluent while demonstrating high removal of E.coli pathogens in the dairy effluent. Thus, combination of MCB and IAB in columns will effectively remove contaminants and recover P fertilizer.

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

Target audiences for this project include dairy producers, farmers, college students, state agenicies, non-profit organization related to agriculture, and federal agencies. Since this project provides technical solututions for enhancing environmental, agricultural and energy sustainability at dairy farms, the results from this project can benefit target audiences by publising and disseminating the results with target audiences while educating and training target audiences in collaboration with the extension specialists.
For the results from this project, 1) The major results were published in the top peer-reviewed journals, and presented at the National and International Conferences, 2) Some of results were shared with North Texas Biochar Initiative (the Rural Economic Development Program at USDA) and USDA NRCS, and 3) Some of results were also shared with the dairy producers and agricultural farmers via the webinar and extension publication.

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

Through this project, the integrated anaerobic digestion and pyrolysis at dairy farms for effectively managing manure/wastewater, generating energy (biomethane, syngas, bio-oil) and bioproducts (biochar, biofertilizer) from manure, treating and recycling manure wastewater using biochar, and higher agricultural productivity with biochar. Thus, we will provide sustainable solutions for effective waste disposal, water treatment, wastederived energy production, and waste-derived product for higher agricultural productivity. The outcomes from the project will be beneficial to animal producers (dairy, beef, swine, poultry), wastewater treatment plants, public utilities, and agricultural farmers.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The novel anaerobic digestion of dairy manure with the addition of dairy manure- and waste hay-derived biochar (BC) at 0.1-1% increased the methane production by 36%, and shortened total reaction time by 70%. With 28 million tons of dairy manure annually generated in U.S., this process will produce electricity (6.6 billion kWh/year) from dairy manure which will be $ 0.8 billion/year returned to dairy producers.

The calcium-functionalized BC showed about 90% recovery of phosphorus from the dairy wastewater which can be used as a renewable P fertilizer. With 9.3 million dairy cows and its wastewater (~1.9 billion m3 with average 50 ppm of phosphate) in U.S., the calcium-BC would recover 95,000 tons of P fertilizer/year from the dairy wastewater in U.S. while additional income of $64 million/year for farmers and saving substantial amount of chemical P fertilizer.

The activated carbon products were produced from the dairy manure and waste hay using the novel activation methods. The activated carbons possessed their excellent properties (i.e., 1200-2000 m2/g, 80-85% carbon) and high removal of emerging contaminants in wastewater which were similar to those of commercial activated carbon. Since the global market for commercial activated carbon is $8 billion in 2021 and will increase with annual rate of 7%, additional incomes from the manure- and waste hay-derived activated carbon will be significantly helpful to dairy producers if the manure- and waste hay-derived activated carbon will replace partially current market of activated carbon for water treatment.

In overall, the cost-effective co-production of renewable biofuel (biomethane) and bioproducts (P fertilizer-loaded biochar, activated carbon for water treatment) will significantly enhance bioeconomy in rural areas of U.S. including underserved communities.

Closing Out (end date 09/07/2023)

NATURAL RESOURCES MODELING USING THE SPATIAL SCIENCES

Project Director
Raghavan Srinivasan
Organization
Texas A&M University
Accession Number
1015456

Development of Integrated Framework For solving Natural and environmental assessment at watershed scale

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

The research develops tools and technology to increase the use of the well know models like Soil and Water Assessment Tool (SWAT) developed jointly by USDA-ARS and TAMU with necessary input databases to perform analysis over the cloud computing environment. This tool can be used to perform from micro watershed to river basin level or country level policy, climate change, land-use change, and land management scenarios without needing major computing resources.

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

The HAWQS (Hydrologic and Water Quality System) developed under this project helped USDA and USEPA to perform policy analysis that are otherwise very difficult to perform. The platform developed can help researchers and users of the technology work collaborative over the cloud computing instead of eachone working on their own version of the data on their local computers. The HAWQS platform helps to develop the informated needed to execute the SWAT model rapidly with as much as 90% less time required than the traditional way of building the model and conduct assessment.

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

USEPA, USDA, River authorities, and State agencies such as Oklahoma, Texas, and South Carolina are using the HAWQS platform to conduct environmental and natural resources assessments. In addition, the platform is used by many land grand universities as a teaching tool in their undergraduate and graduate watershed modeling courses. USEPA using the tool for assessing the Waters of the US policy and developing an assessment and report to the US Congress. GAO has used to assess the irrigation use and efficiency in the central plains and wrote a detailed report to the Congress.

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

The project helps everyone assess the land and natural resources and their environmental impact in an open-source platform and helps build collaborative computing between stakeholders, government agencies, and researchers. The method saves time and resources required to do the analysis.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

The Soil & Water Assessment Tool (SWAT) is a nationally utilized model capable of high-resolution simulation of hydrology, soil water interaction, crop growth, and field management, which is available on an Environmental Protection Agency (EPA) supported web platform called the Hydrologic and Water Quality System (HAWQS). The Natural Resources Conservation Service (NRCS) Conservation Effects Assessment Project (CEAP) uses SWAT to guide U.S. Department of Agriculture (USDA) conservation policy and program development and help conservationists, farmers, and ranchers make more informed conservation decisions. HAWQS/SWAT was used for the 2020 national EPA "waters of the United States" (WOTUS) rule making and its current revision to ensure clean and safe water in all communities—supporting human health, animal habitat, agriculture, watersheds, flood management, local economies, and industry. The EPA also used SWAT to amend the Meat and Poultry Processing (MPP) effluent guidelines which covers wastewater directly discharged by slaughterhouses, further processors, independent renderers, and poultry processors. These amended requirements are incorporated directly into National Pollutant Discharge Elimination System (NPDES) permits. In addition, HAWQS/SWAT has been used on various research and methodology development projects, including a USDA-Agriculture and Food Research Initiative (AFRI) research grants, inputs for the EPA- Watershed Management Optimization Support Tool (WMOST), and with EPA-ORD projects evaluating climate change impacts. There have been over 5,000 peer reviewed publications with over 1,800 published within the past 3 years. Currently, there are 8,000+ graduate students using SWAT for modeling research in pursuit of Masters and Ph.D degrees across multiple disciplinaries including hydrology, climatology, economics, agriculture, and biology.

Type	Projects / Programs
Projects / Programs without a Critical Issue	0

Not Provided