FY 2020 Annual Report of Accomplishments and Results

Oklahoma
Langston University
Oklahoma State University
[insert name of Institution reporting in this document]
[insert name of Institution reporting in this document]

I. Report Overview

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

1. Executive Summary (Optional)

No Updates – See Plan of Work

II. Merit and Scientific Peer Review Processes

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

Process	Updates ONLY
1. The Merit Review Process	No Updates – See Plan of Work
2. The Scientific Peer Review Process	No Updates – See Plan of Work

III. Stakeholder Input

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

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

IV. Critical Issues Table of Contents

No.	Critical Issues in order of appearance in Table V. Activities and Accomplishments
1.	Youth Development
2.	Family and Child Resilience
3.	Human Health and Hunger
4.	Personal Finances and Job Readiness
5.	Environment and Natural Resources
6.	Animal Production Enterprises
7.	Plant Systems
8.	Economic Development and Poverty Alleviation
9.	Food Safety and Food Insecurity

V. Activities and Accomplishments

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

No.	Project or Program Title	Outcome/Impact Statement	Critical Issue Name or No.
1.	**ATV Safety**	Issue - Serious ATV injuries affect more than 100,000 people each year in the United States. 60 percent of ATV deaths happen on public roads and highways across the United States. Recent estimates indicate that ATV injuries result in as much as $6 billion annually; this estimate includes $868 million in medical costs, $1.2 billion in lost productivity, and $3.8 billion in reduced quality of life. The rural state of Oklahoma averages between 18 and 24 ATV-related deaths each year and ranks between 15th and 20th in	Youth Development

		the nation in ATV fatalities over the past few years. Oklahoma also has one of the nation's highest rates of injury for those 16 and under. Close to 90% of ATV crashes in Oklahoma occur with drivers under age 16 driving an adult sized ATV. Over a seven-year period 737 patients were admitted to the OU Medical Center Trauma One Hospital alone with ATV-related injuries. Response – The Oklahoma Farm Bureau/ Oklahoma 4-H ATV Training facility is operated with the purpose of promoting safety and reducing the incidence of ATV accidents amongst youth in Oklahoma. Certified ATV Safety Institute courses are provided at the center providing students 2 hours or e-learning and 3 hours of hands-on instruction covering proper fit, weight shifting, and hazards using 11 riding exercises. Impact – 110 youth and 27 adults successfully completed the course passing both an e-course and hands-on demonstration showing that they understand the golden rules of ATV Safety.	
2.	**Tuesday Tool Time**	Issue: Early in the Pandemic it was recognized 4-H Volunteers were going to need to stay connected with their club memberships. Rather than focusing on a "new normal," Oklahoma 4-H shifted into a proactive mode to assist volunteers in modifying tools, techniques and delivery modes which would meet the needs of 4-H'ers. It was recognized that families and members were going to need to keep things as normal as possible with restrictions and guidelines being required at the local, state, university and federal levels. The need was based on research provided by the Essential Elements of Youth Development. It is accepted best practices that youth were going to need to maintain contact with caring adults, fellow club members and provided positive engagement in activities while being safely homebound.	Youth Development

		It was also recognized Extension could be complementing and assisting schools by helping volunteers and families in making project work connections to school assignments. Response - This program is the result of modeling features of the I.S.O.T.U.R.E. model by engaging volunteers in significant roles while utilizing their experiences and talents. Partnering with the State 4-H Volunteer Board both as an advisory group and talented professionals, we knew volunteers were going to need assistance in finding creative ways to reach out and keep youth engaged in fun and educational experiences. Volunteers were no different than staff, we all had to quickly learn how to effectively use technology with a few adjustments in the delivery method. A series of four webinars titled "4-H Tuesday Tool-Time" were outlined. The thirty-five minutes sessions contained "core" content, it's applied context, prepared activities and weekly challenges. Sessions were recorded and later edited and developed into packaged Learning Management Systems which could be completed later or revisited. Each lesson contained the following components; a 4-H Connection, research based content, a "how to" for applying the knowledge through online learning, educational activities, recreation and personal growth. Each session modeled what we wanted volunteers to do with youth. Impact - Volunteers engaged in the four sessions gained skills, received resources, and developed lesson plans for engaging members virtually. Outcomes:	

		1. A process using Extension and volunteer resources allows for a quick and timely response to a critical community need. 2. This "model" has several levels of "modeling" program execution: a) Any Extension professional can modify the concept and working outline for any program area. b) It is a practical illustration and application of the ISOTURE model, volunteers being selected, trained, utilized and evaluated "modeling" the engagement of volunteers in significant roles. c) The sessions modeled how volunteers could engage youth in remote learning. d) A variety of teaching and learning styles, delivery modes, and PYD models were introduced/reviewed through volunteer continuing education. • Statewide – 34/77 counties had one or more participants. • 82 volunteers participated in one or more of the four live webinars. • 40 volunteers participated in one or more of the four recorded LMS. • Volunteers and Extension professionals from Minnesota, Wyoming, and Virginia participated in the programming.	
3.	**Food, Fun and 4-H (FF4H)**	Issue: Schools were closed, activities cancelled, churches went online and busy lives came to a halt. For many families it was the first time they were not running from activity to activity. Restaurants closed, some supplies were limited, families were home and an opportunity to engage youth, adults, life skills and fun was created. Response: The Food, Fun, 4-H program promoted youth and adult partnership in preparing recipes and participating in provided educational activities. The electronic mailing offers 4 recipes based on the monthly theme, background information, two educational lessons, dinner conversation topics and a family physical activity challenge. A parent reported that her son went to the mailbox every day in anticipation of this FF4H utensil kit. The program provided youth with pride, a sense of	Youth Development

		accomplishment and new skills. Due to the pandemic, we discovered that often ingredients we had planned to use were not readily available. The team adapted recipes each month as needed and provided families the option to adapt based upon personal needs and availability in their area. "I wish this program was all year. I learned something new every time we had to cook. I am adding to my cooking utensils with my allowance. I want to keep learning how to cook so I will be able to cook for my family." Dayci, 4-H member. Impact: Over 700 families receive the newly developed Food, Fun, 4-H electronic mailing. At the conclusion of each month, youth submitted a report answering three questions and sharing two photos. This program not only taught life skills to youth, but through monthly reporting we learned that FF4H brought together extended families, neighbors and friends. This program resulted in increased interest in the Food and Nutrition project area. This program not only promoted cooking skills and nutritional literacy, but also taught youth how to be a smart consumer through planning, time-management and budgeting. After the first month's kit was mailed, 84% of youth reported and submitted their photos. 57% of participants who received the mailed utensil kit completed the entire program for four months. The Harrison family responded, "Thank you for giving us the opportunity to participate in this program! We have witnessed our kids gaining new culinary experience and skills! One of our top take-aways is how the kids acquired the skill of planning and dividing tasks to accomplish the meal. Hitting the target of completing a whole meal provided them with a great sense of accomplishment!"	

4.	**4-H Youth STEM Technologies (LU)**	Issue: With increasing demand for diversity within STEM career fields throughout the nation there is a need for minority youth to be exposed to STEM technologies early in their academic career. The 4-H youth program is a proven way to provide STEM exposure and experience to minority youth. With local schools reducing school hours to a four-day week and many urban schools reducing funding for STEM activities, there is a need for more STEM activities. New skill sets are needed to meet the needs of the current information industry. Response: A program was initiated called the Langston University 4-H Game Changers Coding Program. These two coding events were held in February and during the first week of March. The coding program is intended for rural youth to learn about gaming, math, computing, and coding. There were two events held before COVID-19 forced the shutdown of the university. Results: The two events were attended with 5 youth participants who learned about coding, how to use math in a game setting to solve problems and learning about coding applications. The participants included African American youth from local rural communities. Continuation of the coding academy was not possible due to the onset of the COVID-19 Pandemic, but plans are being made for the upcoming year.	Youth Development
5.	**Family and Child Resilience**	Children in Oklahoma are twice as likely as the national average to experience three or more adverse events such as abuse, neglect, or violence during their lifetime. Family dysfunction increases these numbers to at least 300,000 children per generation. The state ranks second in the nation for number of divorces. Divorce has negative impacts on parents and youth and increases the risk of negative outcomes in youth. Youth	Family and Child Resilience

		whose parents divorce have a 25-30% increased risk of suffering a mental health condition. Improving parenting skills, family breakdown, and youth ability to overcome adversity are critical to Oklahoma's future. So as to advance the socio-economic development of the state, and have an impact on issues that address the critical areas of child and family resilience, Family and Consumer Sciences Extension educational programs and resources were provided to Oklahoma adults; specifically targeting parents. In response to the challenges posed by the COVID-19 virus, Family and Consumer Sciences state specialists and county educators continued to provide quality researched-based educating through various virtual platforms and in-person while following state precautions and social distancing protocol. Oklahoma State University's Co-Parenting for Resilience program helps divorcing or separating parents reduce the negative impacts of the divorce on their children and fulfills the state-mandated requirement of education for divorcing parents. In 2020, Co-Parenting for Resilience classes were provided both in-person and online, to 1,302 parents in 45 Oklahoma counties. Evaluation results show that Co-Parenting for Resilience is effective at helping reduce the impact of divorce on children and increasing paternal coping and positive parenting. Comments from parents who completed the program include: –"I really appreciate this class; I often refer back to my notes on how to be more engaged with my children" and "I feel so much better about my future and my kids. I feel like now this is a boulder or mountain that I have climbed. Thank You." 91% of Co-Parenting for Resilience participants became more likely to encourage their child to have a positive relationship with their other parent	

		81% of Co-Parenting for Resilience participants became more likely to approach parenting as a joint effort 81% of Co-Parenting for Resilience participants became more likely to view their child's other parent as a valued member of the parenting team	
6.	**Human Health and Hunger**	Poor diet and physical inactivity increase the risk of obesity, which in turn increases the risk of diabetes and cardiovascular disease. Eighteen percent of Oklahoma adolescents are considered overweight and an additional 17% are considered obese. For adults, 35% of Oklahomans are overweight and an additional 37% are considered obese. Oklahoma's above average poverty rate has led to high levels of hunger and food insecurity, which is associated with chronic disease. Food insecurity is linked to lower reading and math scores, and lower high-school graduation rates for youth. For the adult population, food insecurity decreases educational achievement, increases healthcare costs, and weakens the labor force. Poor food resource management skills and a lack of food preparation and food safety skills are detrimental to the health and welfare of Oklahomans. In order to advance the socio-economic development of the state, and have an impact on issues that address the critical areas of food, nutrition, and health, Family and Consumer Sciences Extension educational programs and resources were provided to Oklahoma children, youth, and adults; with target groups including parents, teachers, adult volunteers, middle to low income families, caretakers, agencies & service providers, schools, restaurant employees, food handlers, community leaders, and policy makers. In Oklahoma, 15,500 lives could be saved annually through better prevention and treatment of chronic disease. In response to the challenges posed by the COVID-19 virus, Family and Consumer Sciences state specialists and county educators continued to provide quality	Human Health and Hunger

		researched-based educating through various virtual platforms and in-person while following state precautions and social distancing protocol. Community Nutrition Education Programs (CNEP), a service of the Oklahoma Cooperative Extension Service, utilizes Expanded Food and Nutrition Education Program (EFNEP) and Supplemental Nutrition Assistance Program Education (SNAP-Ed) funding to improve the health and nutrition status of low-income Oklahomans. . Youth programs are taught both in- and outside school settings and adult education is delivered to individuals or groups. In 2020, 20,583 youth participated in programs such as Show Me Nutrition, Teen Cuisine, OrganWise Guys, Farm to You, and KIK It Up. Through funds made available via the OrganWise Guys, an elementary school was able to build 2 indoor mini green houses and also began 2 multi-level planter box gardens full of herbs and vegetables. Participant and instructor comments include: “After learning about whole grains and carbohydrates, the instructor noticed the kids took a huge interest in finding whole grains in their lunch items and snacks. They were actually searching the packages and discussing it during lunch.” “I’ve had students tell me they have each food group on their tray at lunch or identify a specific food group. In the morning assembly we read the menu and call on students to identify specific food groups.” One teacher stated the students started reading their food labels and supporting each other’s successes. A teacher stated, “My students are willing to try new foods and enjoy being introduced to things they wouldn’t normally eat.” In 2020, 1,515 adults participated in the Fresh Start program and learned valuable skills needed to consume a healthy diet and be physically active on a limited income. One participant learned how to prepare healthier food for her family. She also lost 10 pounds during her time in the	

		program. “My spouse and I feel so much better… We have more energy and feel better during the day.” 82% of the 6,901 Show Me Nutrition graduates improved their abilities to choose healthy foods 82% of the 372 Teen Cuisine graduates improved their abilities to choose healthy foods 81% of 356 OrganWise Guys graduates improved their abilities to choose healthy foods 97% of the 1,008 3rd-5th grade students surveyed following the Farm to You exhibit identified foods they should eat for good health 68% of the 165 KIK It Up graduates improved their abilities to choose healthy foods 95% of the 771 Fresh Start graduates improved in one or more dietary quality areas In order to improve the health of Oklahomans with Diabetes, the program Live Well, Eat Well, be Active, with Diabetes (LEAD) was presented to 46 Oklahoma adults. One participant reported “My blood pressure is now normal and I won’t need to go on blood pressure medication. I lost 5% of my beginning weight in the first twelve weeks of the program and am close to my weight loss goal!” 72% of Live Well, Eat Well, be Active, with Diabetes participants have maintained or lost weight 63% of Live Well, Eat Well, be Active with Diabetes participants are in better control of their blood glucose To improve food handling, preparation, and preservation skills, programs such as Cooking for 1 or 2, Food Safety for Seniors, and My Plate for My Family were presented to 1,392 adult participants. The Home Food Preservation program was attended by 202 adults and youth. An FCS	

		County Educator commented, "While visiting with an older adult, she mentioned that my Facebook post about food safety and cleaning out your refrigerator prompted her to clean her refrigerator food drawers and shelves. It took her two days since she was unable to stand for a long period of time but she got it clean!" 90% of Cooking for 1 or 2 participants increased their safe food handling practices 95% of Food Safety for Seniors participants intend to use safe food handling and food storage skills 84% of adult and 83% of youth Home Food Preservation participants plan to use safe and effective food preservation practices	
7.	**EFNEP (LU)**	Issue: Over half a million Oklahomans live in households that are food insecure. Nearly a quarter million live in households with "very low food security," meaning their eating patterns were disrupted and food intake was reduced because they could not afford enough food, according to Food Security and Health. Oklahomans also face several diet-related chronic health problems such as obesity, heart disease and diabetes. According to the United Health Foundation, Oklahoma ranks 46th among all states for overall health. Up to one out of every five children in the United States is overweight or obese, and this number is continuing to rise. Oklahoma has obesity prevalence equal to or greater than 30%, according to the Centers for Disease Control and Prevention. Oklahoma placed last in line for fruit and vegetable consumption. The rising epidemic of obesity in the State of Oklahoma has increased (all statistical data has been provided as of 2013 from their respective sources listed). Unhealthy eating habits have been identified as the reason for diseases such as high blood pressure, diabetes, weight control, cancer, and other illness.	Human Health and Hunger

		Response: The LU-EFNEP program has focused on three main priorities which includes improving diet quality and physical activity for adults and youth, improving food resource management, and improving food safety. During the onset of the pandemic, Langston University Extension staff had to move to a more virtual engagement environment and resorted to additional cold-calling methods to continue programing. In addition, there have been some staff changes that have provided our team members an opportunity for expansion. Even with such tumultuous challenges we are very happy to report that programing is still taking place and new partnerships are still developing. We have made inroads into a new and emerging farmers' market, nursing care facilities, as well as dietitian centers to assist with nutrition informational delivery services. We have been able to partner with 5 new Community Based Organizations since May of 2020 and have held virtual and outdoor in-person classes and informative sessions on the program and mission of the Langston University SAAS-COEP. We were able to attend the national meeting virtually as well as make updates to the new virtual program reporting guidelines for recalls. Results: Participants gained knowledge and skills that assist in changing their behaviors relating to eating more vegetables and fruits, consuming more low-fat dairy products, eating fewer high fat foods, meal planning, reading food labels, comparing food prices, sanitation, food preparation, food budgets and related areas. Participants have provided testimonials that their awareness of healthier eating has been improved because of the courses provided by Langston University Extension staff.	
8.	**Personal Finances and Job Readiness**	In Oklahoma, 21% of residents have low financial well-being and 15% live in poverty. Twenty-two percent of the state's households are	Personal Finances and Job Readiness

		underbanked; although they have a checking or savings account, these Oklahomans use alternative and often costly financial services such as non-bank money orders, check-cashing services, payday loans, rent-to-own services, and pawn shops for basic transaction and credit needs. Twenty-six percent of jobs in Oklahoma are lower wage jobs and 12% of Oklahomans aged 16-24 are neither in school nor employed. In order to advance the socio-economic development of the state, and have an impact on issues that address employment, personal financial management, and quality of life, Family and Consumer Sciences Extension educational programs and resources were provided to Oklahoma children, youth, and adults; with target groups including youth, adults, community leaders, job seekers, and businesses. In response to the challenges posed by the COVID-19 virus, Family and Consumer Sciences state specialists and county educators continued to provide quality researched-based educating through various virtual platforms and in-person while following state precautions and social distancing protocol. To teach adults basic money management skills such as budgeting, setting financial goals, and credit management, programs such as Check and Balance and Dollar Decisions, were presented to 220 adults. By using the skills they learned, participants will have greater confidence in their financial future. 66% of adult participants stated their intent to improve financial planning and responsible money management practices. We presented Reality Check and Welcome to the Real World, both interactive financial simulations, to 2673 youth in grades 8-12 as opportunities to learn basic life skills such as budgeting and managing a bank account. Students are assigned a role with certain circumstances such as marital status, number of children, income, and monthly expenses.	

		The goal is to go through day-to-day activities representing one month without overspending. A classroom teacher commented, "This program is so necessary for the students. It helps prepare them for what is coming when they are out of high school on their own. Life isn't cheap." 82% of youth understand the importance of saving money To assist Oklahoma businesses and communities, PRIDE, a customer service workshop, was presented to 59 front-line employees in the service industry. Participants learned that their attitude, customer service skills, and the first impression they make, can have a positive or negative impact on not only their employer, but also their community. Comments include, "The most important thing I learned is that customer service and tax money are connected. Visitors come back and spend money in our town when they have had a good experience." and "I learned it is important to resolve problems quickly to reduce negative opinion of our business, and treat internal and external customers in a better way." 35% increase in understanding the role of customer service in building community support for a business 42% increase in understanding the role dissatisfied customers play in business loss 50% increase in understanding the importance of training employees to publicly support their organization We conducted job readiness programs such as Pathways to Success, which teaches basic living skills to low-income Oklahoma adults, with 184 adults and older youth to help Oklahomans improve both their marketability to potential employers as well as opportunity for success in the workplace. An FCS County Educator related this story, "A young man was in the Overcoming Obstacles program at the Tech Center for two years. He often talked about dropping out of school due to no source of income. We	

		worked on ways to solve that problem and he was able to get a job at a local grocery store. As a result of our work on the obstacles that stood in his way, he has maintained employment and will graduate this year with plans for a career." 86% participants have the confidence and skills necessary for successful workplace conduct and interactions 84% of participants have the skills necessary to successfully obtain employment	
9.	**Mitigating Impacts of Invasive Species and Climate Change on Oklahoma's Grasslands and Forests**	Issue - – Agricultural production and other ecosystem goods and services on grasslands and forested areas in Oklahoma are threatened by invasive species and climate change. Early research has suggested that negative effects of invasive species are and will continue to be exacerbated by climate change. Research and Extension faculty and students are studying a variety of invasive species/climate change topics that are relevant to either maintaining or restoring the health and sustainable function of these agroecosystems including invasive grasses, animals, and soil microbiomes. Old world bluestem (OWB) was planted as possible improved forage grass on extensive tracts of rangeland in the southern Great Plains in the mid twentieth century. However, they now have invaded native grass stands and threaten their stability, including what remains of the tallgrass prairie ecosystem. Kudzu is an invasive perennial vine that has been spreading rapidly since its introduction in the southeastern United States in 1876. Feral swine are invasive throughout the southern states and have become an increasing problem in southern Oklahoma. Direct consumption and foraging behaviors such as rooting, digging and trampling result in damage and economic losses to a pecan industry in Oklahoma that generates about $28 million dollars in revenue,	Environment and Natural Resources

		annually. Invasive Eurasian earthworms are widespread in North America, causing substantial harmful effects on plants that are dependent on AM hyphae. We are studying how these interactions influence soil health, plant species composition, and plant forage quality in Great Plains rangelands. Drought and climate change that may intensify drought effects have the potential to reduce productivity of the approximately 1,000,000 acres of loblolly pine plantation (as well as native shortleaf pine stands) in Oklahoma, which form the underpinning of a $3.1 billion industry. Response/Action- Drs. Rodney Will, Chris Zou, and Omkar Joshi investigated the effects of climate variability and management on diameter growth of shortleaf pine (Pinus echinata) in southeastern Oklahoma, the drier, western limit of its range. They also investigated the effects of tree harvest, prescribed fire, and 31 years of climate variability on understory aboveground net primary productivity (ANPP) for ecosystems ranging from mature forest to grassland. Impact- The soil microbiome that is critical to plant health is typically degraded following invasion by non-native plant species. However, the value of re-establishing native microbiomes is rarely considered in ecological restoration. Arbuscular mycorrhizal (AM) fungi are particularly important microbiome components, as most native grassland plants are strongly responsive to their native AM fungal symbionts. Mycorrhizal fungal dynamics can accelerate plant succession and the reintroduction of both whole soil and laboratory cultivated native mycorrhizal fungi can be used as tools to improve native plant restoration following eradication of non-native plant species. Restoration of native biodiversity is often minimally successful following eradication of non-native plants due to loss of native	

		soil microbial communities. While native grass species survival was not improved following inoculation with native soil, survival of late-successional forbs was significantly improved when inoculated with native soil. Results show that native prairie species restoration success is linked with belowground microbial communities and that transplanting mycorrhizal plants can improve restoration success following removal of non-native species. Dr. Omkar Joshi found that distribution modeling revealed that kudzu will begin to shift from southern areas to more northern latitudes in the mid to late 21st century. The results demonstrate that by year five, total industry output could be reduced by $167.9 million, which will influence 780 jobs in the most extreme case scenario. The predicted economic loss due to kudzu expansion could act as an incentive for appropriate management practices and plans to be implemented. Our economic impact analysis, along with other outreach and educational materials, can help engage landowners and other non-traditional stakeholders towards creating and enforcing effective management strategies. Dr. Sue Fairbanks and MS student Kelly Boyer found that surficial soil damage by wild pigs (Sus scrofa) in pecan orchards and groves decreased the efficiency of pecan harvest by 34%, above the 10% baseline inefficiency of the shake and harvest method commonly used in pecan operations. This research also provided a link to an online calculator that pecan producers can use to calculate amount of harvest lost and cost, based on amount of pig damage, current pecan prices, and other user-input parameters. In general, herbaceous production was inversely related to tree dominance (basal area) and litter accumulation, and positively related to June precipitation and early and late growing season temperatures.	

		Prescribed fire, through its negative influence on tree basal area and litter accumulation is critical to maintaining highly productive understories and that a three-year return interval is a threshold to stall redevelopment of forest.	
10.	**Mitigating Eastern Redcedar Invasion on Oklahoma's Natural Landscapes**	Issue-- Over 12 million acres of rangeland and prairie have been encroached by eastern redcedar (Juniperus virginiana). The primary reason for this encroachment is the lack of natural fires that maintained grassland prairies and savannas prior to European settlement in the late 1800's. A major concern is that conversion of grasslands to eastern redcedar woodland decreases runoff to streams and therefore reduces water available for municipal and agricultural uses, reduces grass production needed for livestock forage, and negatively affects forest production by invading Cross-timbers and pine stands. Prescribed fire is the most effective tool for returning these landscapes to grasslands but its adoption is limited. At the same time, a biofuel and bioproducts feedstock system that includes the utilization of native herbaceous vegetation, eastern redcedar, and dedicated biofuel feedstocks, such as switchgrass, can provide the underpinning of a regional biofuel/bioproducts industry. Finally, contrasting stakeholder perceptions of factors that affect watersheds such as climate change increasingly impose challenges to successful watershed management. Sustainable management of watersheds require an integrated and collaborative approach among the stakeholders. Response- A series of experiment on small watersheds have been conducted to determine water use efficiency of several vegetation types. Programs to promote management of these vegetation types using prescribed fire have successfully been applied to state and federal land	Environment and Natural Resources

		management agencies. Alternative uses of eastern redcedar, rather than using prescribed fire, have been recommended. Impact- Eastern redcedar encroachment into the post oak forest increases stand-level water use likely because eastern redcedar is using water from shallower soil depths than the oaks. These findings indicate that selective removal of eastern redcedar in oak forests would likely increase water availability for forage grasses that utilize water in shallow soil depths. Averaged across 2017-2019, evapotranspiration was significantly greater in forested watersheds than the grassland watersheds (1,022 mm y-1 for eastern redcedar, 874 mm y-1 for prairie, and 828 mm y-1 for switchgrass) which means there was less runoff to streams from the eastern redcedar encroached areas. The mean water use efficiency was significantly greater (9.47 kg ha-1 mm-1) for switchgrass than for the prairie or eastern redcedar cover types (6.03 and 6.02 kg ha-1 mm-1). These findings indicate that removal of eastern redcedar increases water yield and can increase productivity and water use efficiency. Extension efforts related to prescribed fire is impacting the use of prescribed not only in Oklahoma, but throughout the US and Canada. NREM extension provided hands-on and formal prescribed fire training to the US Army Corps of Engineers, who are major land holders across the state. Now the Corps of Engineers are safely and effectively burning to control eastern redcedar around Oklahoma lakes. Dr. Omkar Joshi and MS student Ravneet Kaur found that a new eastern redcedar industry that manufactured particleboard, mulch, and oil would contribute an additional $96 million per year to the economy of Oklahoma, while generating 319 employment opportunities. In addition, spatial analysis identified two hotspot clusters suggesting that the existing biomass in the northwestern and southeastern counties of the state could	

		sustain such a bioproducts industry for two to ten decades based on the annual feedstock requirement of different operations.	
11.	**Reversing Gamebird Decline in Oklahoma Caused By Changes in Fire Frequency**	Issue- Changes in fire frequency is the greatest current threat to continued agricultural production and many wildlife species of wildlife. Prescribed fire is the most effective tool for maintaining these landscapes but its adoption is limited. Most of the state has experienced increased woody plant cover due to lack of prescribed fire. This has led to an increase in catastrophic wildfires in Oklahoma and throughout the Great Plains. Related to this lack of fire is the decline of northern bobwhite (Colinus virginianus) in Oklahoma. Economically, bobwhite hunting can contribute significantly to local economies. As such, private landowners and Oklahoma Department of Wildlife Conservation are particularly interested in maintaining and enhancing bobwhite populations on their lands. Other species such as the declining greater prairie-chicken (Tympanuchus cupido) populations are associated with fire that is too frequent. Response- Research and Extension has been focused on developing an innovative approach to managing grazing lands for livestock production, wildlife management and biological diversity for the past 20 years. The basis for this effort was initially focused on ecological effects of the invasion of woody plants and the potential for integrating fire and livestock management. We have developed approaches to manage Oklahoma landscapes with an interaction of fire and grazing that can enhance livestock production and wildlife diversity by limiting woody plant invasion and enhancing landscape heterogeneity. Using radio and GPS transmitters attached to birds, we have been evaluating how bobwhite and prairie-chickens use the landscape and how management affects their populations. We have also established demonstration plots across the state to evaluate and illustrate to the public how different management	Environment and Natural Resources

		strategies may influence vegetation structure and consequently influence bird populations. Impact- The reproductive success of greater prairie-chickens exhibited a wide range of values under differing short-term and chronic (i.e., drought) weather conditions. These findings suggest that if the weather in the Great Plains becomes more variable, with increasing frequency of drought and extreme precipitation events, wildlife species that inhabit these grassland landscapes will likely experience changes in reproduction, potentially influencing future populations. Further, maintaining heterogeneous grasslands that may provide refugia to mediate these short-term and chronic shifts in weather will be critical to sustaining many of these grassland species. Additional research shows that the season of burn can be important for flowering forbs. An increase in flowering plants means an increase in insect life and seed production, both of which are important for Oklahoma game birds. Continued research and extension efforts though field days and tours by Dr. Goodman and Mr. Weir on the effects of season of burn to flowering forb production has increased land managers knowledge across the state.	
12.	**Genetics/Genomics research program**	Issue- Small noncoding RNAs (sncRNA) alter the expression of genes and are a critically important aspect of the genome. We have sequenced the genomes of all major livestock species and identified many of their genes. However, we cannot realize the full potential of these data without providing knowledge and tools that are easily utilized by biologists and agricultural researchers. Our goal is to deliver new resources and tools to help researchers accelerate the delivery of knowledge from research investments. We will produce biologically relevant data to improve upon current prediction-based tools.	Animal Production Enterprises

		Response/Action- tRNAs in the genome of each species will be annotated using tRNAscan-SE software. If tRNAs have previously been annotated in a species, we will use publish annotations. Software considered to be most current and most widely accepted at the time will be given priority during pipeline development. Improvements must be made as the preliminary pipeline is not automated and currently relies on manual input of tRNA sequences. Impact- The impact of our work has improved the ability for researchers to translate their data sets into knowledge. We have annotated tRNAs in the new bovine reference genome (ARS-UCDv1.2). Further, we have remapped tRNA fragments to the new genome for fetal liver and muscle samples. Publicly available data has been downloaded to OSU research computing servers and analysis has begun. We have developed an increasingly thorough catalog of tRNA fragments in bovine small RNA seq samples and are developing more specific pipelines for Ovis aries and Sus scrofa.	
13.	**Ruminant nutrition of free ranging and confined cattle**	Issue- Cattle production is the leading agricultural product in Oklahoma accounting for nearly 3 billion dollars per year. Oklahoma currently ranks in the top 5 cattle producing states for all cattle and calves. Cows are typically graze native pasture, stockers are raised on improved pasture (often dual-purpose wheat), and then finished in feedlots. Inefficiencies in the all parts of the production cycle affect a producer's income and sustainability. Response/Action- Programs in 2020 focused on 1) the use of byproducts from the cotton industry (whole cottonseed and cotton gin trash) as replacements for roughage, protein, and fat in finishing diets, 2) the use of composite beef x dairy genetics for non-replacement animals, and 3) improving grazing efficiency through strategic supplementation and virtual fencing.	Animal Production Enterprises

		Impact- The finishing experiment suggest cotton byproducts can be effectively used as a source of fiber, fat, and protein in feedlot rations without adverse effects on performance or carcass characteristics. The digestion experiment suggests there are minimal differences between the digestibility of finishing diets containing cotton byproducts and those comprised of traditional finishing diet ingredients. One of the largest cattle finishing organizations in the world, Cactus Feeders, used this information to incorporate cotton byproducts in finishing diets in one of their finishing operations. It is assumed these composite calves will be of more value than calves from straight dairy genetics, but there are questions regarding the management of these calves during all phases of production. Overall performance of composite beef x dairy replacement calves has been impressive with finishing average daily gains of 3.96 lbs/day, feed:gain ratio of 6.4:1, and weight gain from 278 to 1,467 pounds in 308 days. Carcasses were 94% Choice and 47% premium Choice or Prime. Feedyards are already acquiring considerable numbers of dairy x beef composites and have reached out to the Department of Animal and Food Sciences for management and feeding advice on effectively feeding these calves. Strategic supplementation during the late summer increased profitability per steer by $29.69 and $5.40/acre. When stocking rates were increased with summer long supplementation, net returns per steer were increased by over $38.50/steer and $14/acre over standard management even though supplement costs were over $107 per head ($30.50 per acre). Because of the increase in stocking rate, high supplement increased returns per steer by $8.82 and by $9/acre because of the increased performance and reduced land rent cost per head. Increased performance	

		with higher stocking rate more than offset increased expenses associated with labor and supplement purchase in this analysis.	
14.	**Forage Tannins Reduce Methane Emission (LU)**	Issue - The demand for meat protein in the world is increasing rapidly, which necessitates greater levels and efficiencies of livestock production. However, several factors including climate change is expected to adversely affect production of ruminant livestock species. Unfortunately, ruminants contribute to climate change, largely through production of the greenhouse gas methane. The seriousness of the current rate of climate change mandates attention to all sources of greenhouse gases. Therefore, various means of decreasing methane emission by domesticated ruminant livestock have been studied to minimize impact on climate change and increase capture of feed energy. Response - The long-term goal of a research program is to develop practical and sustainable means of minimizing greenhouse gas emission by domestic ruminant livestock to lessen the contribution to climate change and elevate efficiency of production. Much attention has been given to feeding goats lespedeza, a common forage in the southern USA, which contains a class of compounds known as condensed tannins. Effects of other sources of condensed tannins and feed additives have been compared with lespedeza. Diets have included various levels of tannins and different frequencies of feeding. Measures have been repeated over time in long-term studies to investigate potential adaptation of microorganisms in the stomach to adapt to effects of tannins. Moreover, some trials have been done with sheep to see if effects are similar to those with goats.	Animal Production Enterprises

		Impact - Research conducted has shown considerable promise for decreasing emission of the greenhouse gas methane by goats through feeding of condensed tannins found in lespedeza, a forage common in the southern USA. The reduction in ruminal (i.e., a stomach compartment) methane emission has ranged from 30 percent to 50 percent relative to digestible energy intake. Effects have been immediate, with maximal impact on the first day of feeding. Ionophores, a class of antibiotics, and medium-chain and long-chain polyunsaturated fatty acids have yielded similar reductions in methane, but effects have not been additive when given with lespedeza. Effects of tannins on methane emission over time in long-term studies have been consistent with both sheep and goats. Moreover, currently a project is underway to determine most appropriate means of use of a portable calorimetry system to quantify methane emission with groups of animals in natural settings on pasture or in pens.	
15.	**Internal parasite workshop and FAMACHA training (LU)**	Issue: Internal parasites are the number one health issue and the number two cost of production in the small ruminant industry, especially goats. Small ruminant producers have relied heavily upon blanket application of anthelmintics as the sole preventative and curative method. However, this reliance has come with a cost, anthelmintic resistance in the internal parasite population. As such, small ruminant producers need guidance on and instruction in selective deworming and alternative methods of internal parasite control. The Internal Parasite workshop and FAMACHA training is an annual producer-education event since 1990. The objective of the workshop is to educate small ruminant producers in sustainable internal parasite control. Feedback from participants is always solicited. In the early years, the workshop/training focused upon fecal egg counts (FEC) as the instrument for assessing parasite burden; however, in recent years, the workshop has emphasized the use of FAMACHA. Participants are	Animal Production Enterprises

		exposed to FEC but not provided experiential learning as in past workshops. Results: Twenty-three persons registered from around the US, 13 attended the live Zoom workshop, 10 took the required quiz, and 5 submitted the required video of COVER, PUSH, PULL, POP (30 sec max). Thus, 5 participants received certificates and purchased FAMACHA cards. Impact: Small ruminant producers were educated in sustainable internal parasite control, which should reduce the reliance upon anthelmintics.	
16.	**Online meat and dairy goat certification courses (LU)**	Issue: Many goat producers obtain information from the World Wide Web. While proper, science-based information does exist on the internet, producers with little to no livestock experience have no background to discern "good" versus "bad" information. Langston University led a consortium of fellow universities and goat associations to develop an authenticated, science-based online presence. The objectives of this program are 1) to provide reliable educational information incorporating a Quality Assurance Program that is suitable for dairy and meat goat producers, county agents, and other agriculture professionals and 2) to provide testing methodologies allowing for certification of dairy and meat goat production for those producers desiring certification. The online certification site (http://certification.goats.langston.edu) has training modules for a dairy goat track and a meat goat track. To qualify for Dairy Goat Producer Certification, a participant must successfully complete 18 core modules and 7 of 10 elective modules. To qualify for Meat Goat Producer Certification, a participant must successfully complete 21 core modules and 9 of 12 elective modules. In both tracks, participants are required to take a pre-test before accessing module contents. Participants	Animal Production Enterprises

		have one attempt at the pre-test and then later an unlimited number of attempts to take the post-test. Participants cannot access the module contents before taking the pre-test. The objective of the pre-test is to measure participant's knowledge before reading module content and the objective of the post-test is to measure knowledge after reading module content. The difference between the post and pre-tests is an indication of knowledge transfer. In 2020, Spanish versions of the certification courses were added. Further, the English and Spanish courses were loaded onto small, handheld computers called Raspberry Pi for use by producers who have limited or no internet access. A limited number of these computers were given to persons in Oklahoma and Puerto Rico to test the system before more widespread distribution in 2021. Results: To date, 800 and 2,123 participants have enrolled in the Meat Goat and Dairy Goat certification course (English), respectively, and 26 and 37 participants have enrolled in the Meat Goat and Dairy Goat certification course (Spanish), respectively. The number of participants completing and receiving certification for the Meat Goat course is 466 and 14 and for the Dairy Goat course is 168 and 24 for the English and Spanish versions, respectively. Certified participants represent 49 US states, Puerto Rico, and 18 countries. Overall pretest scores for required and elective modules averaged approximately 71%; thus, most producers were required to study module content and take the post-test. Post-test scores are roughly 30% higher than pre-test scores, indicating a gain in knowledge by the producer. Impact: Some small ruminant producers may not have extensive livestock production experience. These certification courses are a trusted source of	

		science-based goat production information. The online availability of these resources allows producers to access and find needed information, using it to enhance farm productivity and income and to safeguard the health and welfare of their animals.	
17.	**American Institute for Goat Research website (LU)**	Issue: Many goat producers look to the Internet for information. While proper, scientifically based information does exist on the Internet, producers with little to no livestock experience have no background to discern "good" versus "bad" information. Many producers have turned to the Langston University website for unbiased, research-based information. In 2015, the American Institute for Goat Research unveiled a Drupal server to meet branding requirements of Langston University. Tracking code for Google Analytics, which is the enterprise-class web analytics package that evaluates website traffic, was enabled for the site and merit review was based upon pageviews and bounce rate from Google Analytics. Results: Overall in 2020, there were 82,224 visits (down 17% from 2019). This decrease is attributed to server downtime from February 29 to April 17 (48 days), July 9 to July 16 (8 days), September 27 to September 28 (2 days), and October 17 to October 19 (3 days) for a total of 61 days (17% of the year). American Institute for Goat Research (AIGR) has a stand-alone server but the URL is dependent on the university's internal DNS. In the first outage instance, Langston University updated its server system software but neglected to revise their DNS, which rendered the AIGR server invisible to the public. The second instance was due to a Drupal/Moodle database error that was problematic to fix. The third and fourth instances were due to power failures that cause the server to improperly reboot and had to be manually rebooted. Visitors spent an average 1 minutes and 23 seconds, which is down slightly from 2019 (1	Animal Production Enterprises

		minutes, 31 seconds). The United States accounted for 47% of all users. Every state in the union visited the web site with Texas accounting for the most users. The trend toward mobile devices (smart phone) is also observed with visits to the website. Over a 5-year period, mobile visits have increased greatly. Desktop visits accounted for the majority of the early visits but have been declining, percentagewise. The vast majority of users enter the web site via a search engine such as Google, Bing, DuckDuckGo, etc. The second major avenue is bookmarked entry, followed links embedded in the AIGR Facebook page, and then linked referrals from other web sites.	
18.	**Aquaculture (LU)**	Issue: Oklahoma ranks in the bottom 10 states based on aggregate economic output, infrastructure and quality of life. Residents are challenged with high underemployment, stagnant wages, rising costs of living, and access to healthy food options. It is among the most food insecure states, with over 650,000 food insecure residents. Aquaponics is an integration of soilless crop production (hydroponics) and aquatic animal production (aquaculture) into a single food production system. We believe that the aquaponics industry in Oklahoma and the immediately surrounding states to be an infant industry and have potential to provide a source of ready protein and vegetables for communities while providing an income source. Over the past 10 years, interest and numbers of facilities have grown rapidly. There are now approximately 200-400 aquaponics Community members in our southern region. Unfortunately, there is high attrition rate which is believed to be related to lack of information and training opportunities specifically targeted to the challenges of Oklahoma (Dr. Gorczyca-Southerland, Oklahoma department of Agriculture, Division of Animal Industries). However, the potential for success using aquaponics	Animal Production Enterprises

		in Oklahoma and the surrounding region is growing because of the increasingly arid environment, which stimulates its profitability. Response: The aquaculture research team planned and implemented an educational workshop called "Building Your Aquaponic Business." This one-day workshop held on October 17, 2020 was hosted together with the Aquaponics Association and a local aquaponics business called Symbiotic Aquaponics. During the workshop participants were able to engage with subject matter specialists, agribusiness professionals, and aquaponics experts through the Zoom online platform. Consultants from two private Aquaponics companies in addition to other participants from ARS-USDA, Redlands Community College, the Aquaponics Association, and Langston University collaborated in successfully completing the workshop. Workshop topics were selected through previous aquaponics surveys and questions from the social media aquaponics association members. These topics covered business development, economics, market assessment, refining aquaponics processes for efficiency, developing sales strategies, and creating retail relationships for aquaponics producers. Impact - Professional development has been provided for the larger international community on the business of aquaponics via virtual workshop utilizing a collaborative effort with the Aquaponics Association's "Run the World Platform." Over 59 registrants participated in the virtual workshop that had seven speakers and a tour of a private aquaponics facility. There were attendees from throughout Oklahoma and the United States. In addition, there were 14 international attendees to the virtual workshop.	

19.	**Plant breeding and genetic resources**	Issue- Whether it is a wheat variety that provides a better quality flour for family dinner or a turfgrass variety that reduces water consumption on a golf course, plant breeding and molecular genetics are rudimentary to plant-based agriculture, and the end products of plant breeding affect every person, every day. In addition to the scientific discoveries and end-use products fueled by plant breeding, the genetic material developed and released from our program provides economic opportunity for everyone in the value chain from the independent seedsperson selling an OSU-released wheat variety in rural Oklahoma to the corporate licensee marketing a turfgrass variety to a sports field manager in Kansas City. Response- We have developed cross-disciplinary teams of researchers and extension specialists focused on scientific innovation and dedicated to incorporating scientific advancements into products that affect the lives and livelihood of our stakeholders. Current emphasis areas include field-based plant breeding programs focused on small grains, turf, forage, and biofuel crops. In addition, team members focus on basic science and discovery at the molecular level to build genetic resources and knowledge that will one day find its way into end-use products. Impact- Our wheat molecular genetics made a major discovery regarding the highly utilized Lr34 leaf rust resistance gene. Lr34 is a resistance gene against leaf rust, and it was reported to have one copy in all hexaploid wheat or common wheat cultivars in the field. This has long been the consensus among scientists throughout the world because of originally being reported as a single copy in the journal Science. However, we discovered that our Oklahoma wheat cultivar Duster has two copies of the Lr34 gene, the resistance allele Lr34a and the susceptibility allele Lr34b, resulting in the unique Lr34ab allele. The co-existence of the two genes in	Plant Systems

		Duster is due to a duplication of a chromosomal fragment including Lr34. Due to the groundbreaking nature of our discovery, we were required by reviewers to perform additional experiments above and beyond the normal standard for publication. Our further testing provided additional experimental evidence confirming that Duster indeed has the unique Lr34ab allele (Fang et al., Theor. Appl. Genet., 133: 2183–2195, 2020), proving that two copies of the gene exist in some cultivars. The research conclusion is very important for wheat breeding programs in the great Southern Plains, because Duster has been extensively and intensively utilized in crosses. We should be cautious in selection for genotypes of Lr34 in breeding new wheat varieties. Five new wheat varieties were released in 2020, offering improved yield, disease resistance, grazing tolerance, insect resistance, and improved end-use performance. Our 2020 release of the variety Breakthrough provided the first documented case of Wsm1-mediated WSM resistance since the older and less adapted variety, Mace. Breakthrough competes agronomically with the variety Joe, which has Wsm2-mediated resistance, but provides superior end-use quality. The release of Butler's Gold fulfills a need for wheat with unusually fast reproductive growth. The extremely variable weather patterns in the southern Great Plains sometimes delay wheat planting, leaving producers with the choice to plant late and risk crop loss or leave land fallow. Butler's Gold provides a choice for farmers who face season-disrupting conditions or late harvest of a summer crop and are trying to recover with a late-planted wheat crop. Butler's Gold also provides premium quality, for which ADM commented in Sept. 2020, "awesome wheat characteristics and dough trifecta (high absorption, strong farinograph, and strong bake)".	

		Our 2020 release of the variety Uncharted will feature the first commercial deployment of the resistance gene Bdv2 from Thinopyrum intermedium in the Great Plains. This is in addition to Bdv1 inherited from the variety Duster. This novel two-gene stack will provide an incomparable wall of defense against Barley yellow dwarf virus, reducing the need to apply pesticides and increasing crop yield. Bermudagrass turf varieties developed at OSU has been used in 26 states (increase from 13 states last year) including 100+ golf courses, 25+ professional fields, and 25+ college/university stadiums. Our latest variety Tahoma 31 was released in 2017. It is now produced on 22 sod farms in the United States and additional farms in Japan, New Zealand, Australia, China, Italy, Turkey, and Spain. Tahoma 31 has been used in sports fields, golf courses and home lawns. The market penetration of this newer cultivar has expanded quickly.	
20.	**Horticulture Market Gardening School and Agriculture in Action Farm Training Program (LU)**	Issue: There is an expressed need of African American and Native American rural stakeholders for programming in the areas of food production, horticulture, market gardening, and understanding of technology like seasonal high tunnels. Small Scale Horticulture Producers in Oklahoma struggle with controlling weeds and conserving water. Horticulture technology like seasonal high tunnels is in demand because it helps small scale producers extend their growing season to better match market demand during the winter months. These historically underserved communities expressed a desire to grow their own food and better understand healthy consumption of fresh vegetables. The expressed needs were for field and hands-on training in various aspects of horticulture. Response: In response OSU Horticulture Department partnered with Langston University and Noble Research Institute to implement the annual	Plant Systems

		Market Gardening School with a Langston University community partner named Kingdom Community Development Services. The eight-week training series included 6 hours of hands-on instruction and classroom presentations once a month. Topics included Season Extension, Crop establishment, fertility and water management, fruit production, pest management, marketing, food safety, wildlife control, risk management, winter cover crop, and overwintering vegetables. The purpose of the school was to educate and equip current and future market producers with the management and production skills necessary to generate garden fresh, healthier food. Participants were also familiarized with marketing techniques utilized in the development, establishment, and implementation of a local Farmer's Market. Results: Over 10 participants attended the seasons representing 10 families in the Inola and Wagoner areas and included the mayor of Boley, OK. Produce from the demonstration area was also used to provide vegetables at the Wagoner Farmers' Market. There was a large amount of enthusiasm generated for future growing seasons and expansion of marketing opportunities.	
21.	**Daylily cell, tissue and Organ Culture Program (LU)**	Issue – Daylily is one of few crops that is celebrated annually and grown across a spectrum of environmental conditions around the world primarily for the beauty of its flowers. The industry thrives on faithful reproduction of parental phenotypes that feed customers' interest. To maintain the parental phenotype constancy in the progenies, sexual reproduction is not a preferred choice. Natural multiplication is very slow and can produce fewer new plants as few as two annually in the local field germplasm. To meet market demand, variable modern methods have been developed ranging from new varieties to integrating standard propagation methods	Plant Systems

		with chemical applications. Although successful, those methods are limited to the growing season and cannot be applied year-round to meet customers' demand. Therefore, new modern methods are needed to mitigate the deficiency. One of the technologies of interest is in vitro cell, tissue, and organ culture. Although this technology has been in trial stage for some time, its broad application in daylily is limited, because of the difficulty to multiply daylily in vitro. This challenge has led to industry critiques that several alleged in vitro induced plants are merely stimulated growths of axillary buds that often result in progenies that are different from parental phenotypes and has led to mischaracterization of the efficacy of the technology itself. Several research efforts have often resulted in developing a few usable protocols that often turn out to be difficult to reproduce. Response – A goal of this program is to develop more efficient protocols that can be applied across a spectrum of environmental conditions with minimal environmental requirements. To achieve this, broad studies toward developing organ-based protocols are being carried out at Langston University. Those studies are deliberately conducted under non-restricted environmental conductions and apply broad genotypes aimed at screening up to 250 local cultivars to ensure that resulting protocols cannot only be more efficient but also reproducible. Impact – Current research has resulted in successful development of more efficient protocols that apply tissues and organs such as stem, whole bud, bract, petal and sepal individually as the primary explants for inducing de novo plant regeneration. Those protocols have been very successful in inducing new plants up to one hundred in a single explant, when repeated	

		regenerations are taken into account, in a few months. Moreover, all newly induced plants were identical to parental phenotypes. Considering the breadth of the genotypes and loose environmental conditions of the studies, it is expected that resulting protocols will be successfully replicable across genotypes as well as wide array of geographic conditions. Furthermore, the broad selection of explant types also ensures that daylilies can be commercialized year-round across the globe with mitigated limitations.	
22.	**Integrated Pest Management**	Issue- Insect and disease damage significantly decreases yield in a variety of agricultural crops and ornamental plantings. Major crops in Oklahoma include soybeans, wheat, sorghum, grape, roses, nursery crops, home garden crops, turfgrass, alfalfa, pecan, corn, and pastures. Losses in these commodities amounts to tens of million dollars annually. For example, poorly controlled sugarcane aphid infestations can reduce sorghum yield by 18-30 bushels per acre resulting in a $10 million loss. Response- Cultivar and variety resistance to insect pests and diseases has been a major research and Extension emphasis. Field variety trials are held across the state to account for weather, soil, and management differences. Impact- Soybean cyst nematode levels can reduce yields statewide by $1.6 million. Planting resistant varieties, at no extra cost to the grower, is valued at $800,000. Saving a $15/A nematicide seed treatment is valued at an additional $900,000 for a total impact of about $1.7 million. In addition, the awareness campaign at the state and national level has increased awareness of the nematode pest and the importance of periodically monitoring nematode levels through soil testing.	Plant Systems

		Wheat cultivars resistant to aphids and other key pests can result in increased economic return to growers of at least $2.00 per acre, with wheat valued at $3.25 per bushel, and assuming only 1 million acres planted to these cultivars, translates into $2.0 million for Oklahoma growers. These savings are derived from preventing buildup of damaging insect populations and the need for expensive intervention with alternative management strategies. Additionally, disease resistant wheat cultivars and foliar-applied fungicides are critical to manage important foliar diseases (primarily Septoria, powdery mildew, and leaf rust). A single, timely application of fungicide increased yield by 35% and two timely applications increased yield by 47%. These same single or double applications also increased test weight by 3.9% and 3.6%, respectively. Results of insecticide screening efforts resulted in the registration of three new insecticide active ingredients for control of sugarcane aphid in sorghum. Resistant hybrids and timely insecticide applications significantly reduced yield losses from sugarcane aphid. Forage sorghum is grown on about 12,000 acres, producing 60,000 tons of silage and with a value of about $2.9 million. A rapid sampling protocol is currently being converted into a "glance 'n go" sampling application for smartphones, which should be available for the 2021 growing season.	
23.	**Master Irrigator**	Issue: The Oklahoma Panhandle is one of the most intensively farmed regions in the state. Due to the semi-arid climate in the region, it is heavily dependent on the Ogallala Aquifer for irrigation to ensure stable yields. However, the Aquifer is a finite source of water and well capacities have declined in some areas due to water extraction at unsustainable rates. In a survey conducted before the Master Irrigator program was launched, 87% of the all the respondents who identified as producers or farm managers acknowledged well capacities had declined on their farms. Further, 50% of	Plant Systems

		these respondents confirmed that they had converted irrigated cropland to dryland in the past. To overcome declining well capacities, the producers often join multiple wells to meet crop water demand or reduce irrigated area. Both of these practices have economic implications through increased cost of production per unit area or reduction in overall production due to reduced irrigated area. Use of irrigation scheduling tools such as soil moisture sensors or irrigation scheduling models can increase water productivity and reduce overall water usage. However, adoption of such technologies requires advanced knowledge to apply effectively. In fact, a recent survey indicated that moisture sensor adoption was only used on 5% of farms in Oklahoma, compared to 12% of farms nationally. Therefore, there is need and opportunity for Extension to educate local producers on irrigation management technologies and help them with adoption to achieve greater water conservation and to extend the life of the Ogallala Aquifer. Response: A Master Irrigator Program was developed to provide education to the producers in the Panhandle. An advisory committee was formed to design the curriculum of the program. This committee included producers, NRCS, OSU personnel, and crop consultants. The curriculum developed covered moisture sensors, irrigation models, agronomic practices, irrigation equipment, and related topics over four days of training. The overall goal of this program was to facilitate improved water use efficiency and farm income via increased farmer adoption of advanced water management strategies and technologies. The first program was offered to producers, Extension educators, farm managers and crop consultants in the Panhandle and adjacent areas in January-February 2021. The program involved in-person as well as virtual talks from Extension specialists, crop	

		consultants, and industry personnel. Incentives were available to the attendees in the form of re-imbursement on the purchase of precision irrigation equipment, additional points on EQIP applications, and post program well energy efficiency and irrigation uniformity audits. The first program was attended by 21 persons, off which 12 were producers, 4 farm managers, 1 crop consultant, and 4 Extension educators. These individuals represented approximately 70,000 irrigated acres (it should be noted that two producers did not turn in their survey responses). Impact: Pre- and post-program surveys were used to evaluate the impact of the program. Overall, the survey indicated an increase in attendees' knowledge regarding irrigation. Off all the attendees, 65% had never attended an irrigation education program and a majority of them were interested in learning more and intended to use precision irrigation tools as a result of the training. After the program, 39% of attendees responded that their knowledge about irrigation increased "a great deal", 56% realized a "moderate increase" in knowledge, and only 5% reported "little increase" in their knowledge. Specifically, the largest gains in knowledge were found in regard to moisture sensors and irrigation systems (pumps, center pivots, subsurface drips), followed by budget enterprises and crop-based irrigation scheduling models. However, the attendees indicated that of all these services, they intend to use the moisture sensors the most, followed by irrigation scheduling models, budget enterprises, and improved equipment maintenance practices. The attendees responded positively about the information provided, timing, and connections developed during the program. Audits will be provided to producers towards the end of the 2021 growing season. It is expected that knowledge gained in the program will increase precision irrigation	

		technology adoption. Another post-program survey will be conducted during the audits to assess technology adoption and estimate water savings and the economic impact of the program. However, with the responses from first program we can conclude that knowledge increased and as a result, a behavioral shift among the attendees regarding water conservation and technology adoption is expected.	
24.	**Agricultural Enterprise Training (LU)**	Issue: This is a pressing need because rural communities and specifically socially disadvantaged farmers are often left behind. They have difficulty accessing markets that provide sufficient farm gate prices to enable them to optimize revenue from their farming operations. Research among stakeholders has shown that in spite of the programs to assist them such as the USDA 2501 program and the USDA Farm Service Agency EQIP loans, socially disadvantaged farmers still face barriers in increasing their production. Some of the important deficiencies listed by these farmers are lack of knowledge of programs, timely access to information, and technical assistance (OHBRPI, 2017). In addition, these stakeholders expressed that they needed more outreach and assistance from Langston University and the other land grant institutions in Oklahoma (OHBRPI, 2017). There is an increasing need for educational programming that is specifically tailored for existing and beginning farmers who are farming on land of 50 acres are less. This is an important opportunity for Langston University Small Farms Program to fill this unmet niche for the benefit of socially disadvantaged farmers throughout the Oklahoma. Response: The Langston University School of Agriculture and Applied Sciences worked together with Pawnee Nation College to implement an agricultural enterprise workshop series. Langston University provided the workshop facilitators. The purpose of the series was to prepare Pawnee	Economic Development and Poverty Alleviation

		growers and interested gardeners in planning how to use owned, leased, or allotment land to grow for profit. During each workshop session the participants were guided by the Langston workshop facilitators in developing business and marketing plans and farm management plans. This was to prepare the participants for applying for grant funding or a USDA Farm Service Agency Microloan. Due to COVID Pandemic concerns this training was also offered virtually. There were four workshop sessions that were held every Friday for two hours from Oct. 9 – 30, 2021. Results: Attendance at the workshops included five participants face-to-face at Pawnee Nation College, and additional 6 Pawnee Nation members who were virtual and participants from Nebraska Indian Community College, and a Kiowa Nation member in Anadarko. Fifty percent of the participants had completed an agribusiness and marketing plan by the end of the workshop series. The USDA FSA representative was not able to attend but did provide web-based information. Feedback from the participants resulted in increased interest by Pawnee Nation tribal members in growing on their allotment lands and growing for the local farmer's market.	
25.	**Application Engineering Program**	Issue: Of the nearly 3000+ small and mid-sized manufacturers in Oklahoma, over one-third are located in rural areas and are extremely important to their local economies. Many of these manufacturers are in the Oklahoma City and Tulsa metropolitan areas and the rest are dispersed across the state. The loss or downsizing of even one of these companies (especially in rural areas) can yield devastating consequences. With agriculture and energy industries fluctuating in their labor force needs, rural manufacturers supply much needed jobs in their communities. These manufacturers face particular difficulty in getting relevant and usable	Economic Development and Poverty Alleviation

		information and technical assistance that will keep them abreast of the rapid changes in manufacturing technology. Engineering design expertise is invariably lacking for these companies. Response: To address the difficulties faced by our small- to mid-sized manufacturers, the Division of Agricultural Sciences and Natural Resources (DASNR) and especially the Oklahoma Cooperative Extension Service and the Vice President for Research at OSU (re-investment of indirect costs into the program) have been outstanding partners in supporting the Applications Engineering Program. Since 1997, Applications Engineers (AEs) have been deployed across the state to provide on-site engineering assistance to manufacturers where such expertise is lacking. OSU as a subcontractor to the Oklahoma Manufacturing Alliance (OMA) and partnered with the Career-Tech schools across Oklahoma created this multi-faceted, engineering service which is relatively unique among the MEP programs across the United States. This program is funded by NIST (National Institute for Standards and Technology) through the Manufacturing Extension Partnership (MEP), and OCAST (Oklahoma Center for the Advancement of Science and Technology). The year 2020 saw negative impact due to COVID and global energy market fluctuations on workforce and supply chain issues associated with energy industry along as well non-essential product manufacturers. With three current Application Engineers, we also experienced significant turnover with the Manufacturing Extension Agents (MEA) this last year (about a 70% readjustment of the MEA staff) and hiring of new staff Regional Business Consultants (RBC) to deliver business assessment related services. The year 2020 continued the evolution of the “pay-for-	

		service" model which is coordinated completely through the OMA. The Manufacturing Extension Agents are essential to the contact and relationship development with manufacturers and advancement of project opportunities with the AEs. We recognize that relatively new personnel within the MEA, RBC and AE ranks creates greater need for establishing relationships with existing manufacturers. Dr. John Veenstra has served as the primary PI for the AE subcontract this last year with Dr. Dan Thomas continuing his coordination responsibilities until his retirement in September 2020. Dr. Paul Weckler was involved with Dr. Thomas and has taken over coordination responsibilities as of October 2020. Impact: Clients receiving engineering assistance must agree to a post-project impact assessment. This survey uses procedures developed by NIST for the MEP network. Impact is measured through the economic value of the service to the company as reported by the client. Another measure is the number of jobs created or retained. Both impacts are measured by an independent survey agency. Number of jobs created or retained is translated into economic impact using an income multiplier to compute the direct, indirect, and induced effects due to a change in the number of jobs in the manufacturing sector. The multiplier was developed from data collected from two different sources. First, the average salary for manufacturing in Oklahoma ($39,850) can be taken from the U.S. Bureau of Labor Statistics published information for 2018. Secondly, the labor income multiplier of 1.48 can be used from IMPLAN data for regional manufacturing (based on the most recent survey values of 2020). The total economic impact can be computed by multiplying the average annual salary times the income	

		multiplier to arrive at $58,978 for each new or retained job in the manufacturing sector. Conversations with Dr. Brian Whitacre, Sarkeys Distinguished Professor and Neustadt Chair of Rural economic Development in the Ag Economics department at OSU indicated the OK aggregate labor income multiplier (2019 data) from IMPLAN for the entire manufacturing sector the multiplier is 2.227. This makes sense because we are looking across the entire state and not just a single county (which is more typical in most economic impact studies). Therefore, the labor income multiplier used in the assessment are reasonable and somewhat conservative. The pay-for-service implementation (including at least one retainer-based engineering project activity), along with relatively new personnel, has significantly affected the number of total projects and the resulting impacts when compared to many of the previous years. Also, the project and sales information below reflects only those projects which were "closed-out" in 2020. Several projects started in the past year will continue into the new year until closed out. The year 2020 also included a significant activity tied to robotics for a grant obtained from NIST in collaboration with TMAC (Texas MEP Center) and OMA. The demonstration of robotic technology for precision repetitive tasks and creation of Digital Twin of a factory using simulation were the key goals of this grant. As part of this grant two Cobots from Universal Robots (Robotic arms, UR3e and UR5e) manufacturing demonstration units were brought to Oklahoma. Training on the use of the robots, development of demonstrations, and actual performance of those training activities to MEAs and manufacturers was fully implemented by our team	

		of Application Engineers. The number of hours devoted to the Robot project in 2020 by Application Engineers is well above 750, with Ben Alexander devoting at least 450 hours to this particular program. The grant extends into 2020 with additional training events and the potential for placing these robotic arms into existing manufacturing operations for a selected period of time. In 2020, the Applications Engineers client projects had the following economic impacts, which includes an additional 48 Jobs created and 53 Jobs retained, and a total around 1000 hours directly logged for the pay-for-service program with the OMA for projects closed in 2020. Bottom Line Impact was reported to NIST by the OMA as $15,000,494 which includes a calculation of 15% of Retained sales + 15% change in sales + cost savings+ unnecessary investment avoided. Retention of Sales $6,079,000 Change in Sales $33,148,160 Cost savings $4,544,000 Capital Investment $2,080,610 Unnecessary Investment Avoided $4,572,420 Jobs Created and Retained (101) x $58,978 $5,956,778 Total impact $56,380,968	
26.	**Addressing Food Insecurity through Food Banks and Backyard Gardens (LU)**	Issue: Food insecurity in urban food deserts is a pressing issue that constrain communities and must be alleviated. Over half a million Oklahomans live in households that are food insecure. Nearly a quarter million live in households with “very low food security,” meaning their eating patterns were disrupted and food intake was reduced because they	Food Safety and Food Insecurity

		couldn't afford enough food, according to Food Security and Health. This issue has been greatly increased due to the COVID-19 pandemic. The additional demands during the COVID crisis have made it impossible to meet the large increase in demand even with the help of food banks. People line up 2 hours prior to each event. Response: Langston University staff members worked together with an existing 501c3 organization "Food on the Move" to provide donated food from local restaurants and organizations to families that are food insecure in the North Tulsa area. Due to the Pandemic, the food distribution events were raised from two a month to overseeing nine events a week. Through coordinated efforts over 2.3 million pounds of produce were distributed to over 177,950 families. This was also facilitated through relationships with local and state legislator's such as Congressman Frank Lucas' offices as well as companies such as Go Fresh and RBK (the most recent recipients of the USDA Farm to Family Boxes contract.) With the assistance of the Langston University Extension Educators they averaged 145 volunteers a week serving in locations in North Tulsa, one in West Tulsa, one in East Tulsa, one in Bixby, one in Liberty/Mounds, one in North Owasso, one in South Oklahoma City, and a special event designed to serve Tulsa Public School teachers and staff. Since the pandemic the food distribution outreach has expanded through the state of Oklahoma, working with Impact Ardmore Executive Director, Misty Apala & Representative Tammy Townley to serve Carter County's rural communities: Ardmore, Tatums, Fox, Healdton, Ratliff City, Wilson, Graham and Lindsay, Oklahoma. This program has also been extended to Stephens county. On June 20, 2020 Food on the Move began outreach with the Tulsa Coffee Bunker, to provide weekly food box drops for an average of 700 veterans and their families in Oklahoma.	

		Langston University Extension Educators also responded to the request from food insecure families in North Tulsa for backyard garden education by connecting these families with outside donations and then provided training on setting up their own backyard gardens for home production. Results: The Food on the Move Food Bank effort has resulted an average feeding outreach of 177,950 families receiving food over the past year. The backyard gardening project has resulted in increased interest and expansion in backyard gardening projects among families.	