FY 2020 Annual Report of Accomplishments and Results

Missouri
University of Missouri
Lincoln University of Missouri

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)

University of Missouri

University of Missouri Research and Extension contributed to better the lives of Missourians in 2020. Our program focused on food systems, natural resource management, and healthy people, families and communities. We developed and delivered high priority programs to address needs identified by our stakeholders despite declining state budgets. In 2020, our programs had total contacts of over 1.2 million among Missouri's 6.1 million citizens (392,514 direct contacts and 812,028 indirect contacts).

We continued to incorporate the use of technology into innovative service and product delivery systems, online resources for our stakeholders, and data mapping, visualization, and reporting tools. Our Extension website had millions of page views and content downloads. Funding from grants, gifts, and fee generation exceed the resources appropriated from our state, federal, and county partners. Our goal is to be reliable, responsive and relevant. We accomplished that goal in 2020 by providing research-based knowledge to Missourians aligned with their priorities of improving the community economies, health, and education outcomes.

Lincoln University of Missouri

In alignment with the USDA's top research and extension priority areas, Lincoln University's Cooperative Research and Cooperative Extension Programs continue to conduct innovative research and provide impactful extension activities to address the needs for underrepresented, underserved, small farmers and first-generation students, and contribute to the diversity of nation's future agricultural workforce. We achieved

our goal in 2020 plan of work by disseminating research-based knowledge and delivering outreach activities to our target audience despite the Covid-19 pandemic. The programs have reached over 300, 000 Missouri residents through various program activities. We continue to make efforts working with the state government and legislators to increase the state-match level of appropriations for the amount required by federal government.

The LU research program continued to conduct cutting-edge, impactful food and agriculture research through multi-institution and multi-disciplinary collaborations to effectively address critical and urgent issues and develop sustainable solutions to the problems facing Missouri's agriculture industry and rural communities as well as build up our research capacity to provide better service for the needs of Missouri's farms, especially underserved farmers. The research program currently focused on five critical issues identified, including animal and crop production, food safety, natural resource management, and social-economics. With additional hiring of faculties and completion of new plant research facility, we are strengthening our research expertise and capacity and have created more research projects that address stakeholder's needs around the critical issues identified. The faculty members were still actively in pursuit of extramural funding to support current research and leverage resources provided by federal and state partners. The results generated from capacity research projects are disseminated via scientific publications, extension and web publications, and presentations in national, regional, and local conferences, workshops, and seminars.

The LU Extension program continued our efforts to improve the educational and economic opportunities for underrepresented populations in Kansas City, St. Louis, Jefferson City, and Southeast and Southwest Missouri and develop special Extension programs to meet stakeholder's needs during the pandemic. Expansion of the programs in Southeast Missouri will occur through new construction of a facility. The Programs in the areas of 4H, youth development, family development, community development, health and aging, food and nutrition and urban gardening will assist farmers, families, youth and the elderly as well as entire communities in underserved and underrepresented populations. The Paula J. Carter Center for Minority Health and Aging maintains programs addressing health literacy, health disparity reduction and chronic disease prevention for underserved audiences ages fifty and older. A grant from the Missouri Department of Senior and Health Services funded the Teenage Pregnancy Prevention and Abstinence Programs, which is designed to reduce teen pregnancy and out-of-wedlock births.

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	
2. The Scientific Peer Review Process	

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	**Lincoln University of Missouri** In 2020, Lincoln University of Missouri Research and Extension administrators and faculties frequently visited the served counties and state agencies to share our plan of work and seek feedback for more impactful programming. The types of actions taken by Lincoln University Cooperative Extension and Research (LUCER) depended on the location and type of activity. For example, the targeted audiences for the Kansas City Urban Impact Center (KCUIC) Senior Program were seniors, persons with disabilities and the homeless. The Urban Impact Center in St. Louis holds regular advisory committee meetings, and stakeholder input is solicited at those meetings. The Center for Community and Leadership Development planned and scheduled meetings with stakeholders to discuss and identify community issues, in which stakeholders provided input to develop the method of approach. In Southeast Missouri, individuals were identified from the community who represented various entities, such as the church, school, nonprofit organizations, youth and parents. Semiannual meetings were held to address community needs. The Horticulture Program employed one-on-one conversations as well as direct contact via email and social media, especially Facebook. The Paula J Carter Center on Minority Health and Aging has developed a Lay Leader's Program, and there are more than 100 Senior Citizen Lay Leaders in the program. The lay leaders keep staff informed about the needs of their communities and the relevancy and effectiveness of programs. In general, both traditional and nontraditional stakeholder groups and individuals were contacted and invited for surveys, and special surveys were conducted for nontraditional groups and individuals.
2. Methods to identify individuals and groups and brief explanation.	**Lincoln University of Missouri**

	In addition to the methods to identify individuals and groups mentioned above, Lincoln University Cooperative Extension and Research (LUCER) selected the types of actions depending on the location, type of activity and type of information required. All of the programs used a combination of multiple methods, employing those that would most accurately identify interested individuals and groups. All major programs have advisory committees/boards. Stakeholders serving on the boards are surveyed for input at least once per year, with programming adjusted based on needs and feedback. Participants were identified by the program faculty and specialist during face-to-face conversations, interviews and telephone conversations, responses to email questions from individuals and referrals from other Extension staff, minority stakeholders and collaborators.
3. Methods for collecting stakeholder input and brief explanation.	
4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.	**Lincoln University of Missouri** ● In the Budget Process ● To Identify Emerging Issues ● Redirect Extension Programs ● Redirect Research Programs ● In the Staff Hiring Process ● In the Action Plans ● To Set Priorities ● For Resource Allocation The input received by Lincoln University Cooperative Extension and Research (LUCER) is used to set priorities and restructure Extension and Research programs, as needed; in realignment with the staff hiring, budgeting, and resource allocation. The input is used to strengthen and focus efforts in

	needed areas and to adjust Extension and/or Research activities and the content of presentations. Recommendations were made to the administrator regarding new positions needed to address expressed needs. The core staff of Extension and/or Research will be expanded in response to information gathered. Additional workshops were organized to cover additional training, and additional research focus initiated to reflect the needs. Furthermore, requested information was used to develop grant proposals and passed on to other agencies if needed. Brief Explanation of what you learned from your Stakeholders: **Lincoln University of Missouri** Stakeholder's input is critical for our Research and Extension program assessment and success, which would help the university better serve stakeholders and address their needs. There is a desire to engage, network, connect and share resources, information, services and programs. The stakeholders were able (and willing) to readily identify areas of concern and needs in their respective communities and their perspective of the causal agents. Getting their buy-in to their own community and providing a platform for change provided more of a vested interest in the success of the programs.

IV. Critical Issues Table of Contents

No.	Critical Issues in order of appearance in Table V. Activities and Accomplishments
1.	Economic Opportunity
2.	Educational Attainment
3.	Healthy Futures
4.	Social Justice
5.	Environmental and Natural Resources
6.	Sustainable Agriculture
7.	Health
8.	Education and Communication with Underserved Populations

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.	**Business & Communities Extension Program**	No. of persons reporting taking on new leadership roles as a result of their engagement in community development programs (decision making, emergency management, leadership development, organizational development and capacity building, community economic development, etc.). • Government representatives, civic leaders, employers, and community members at large often have ideas about what they	Economic Opportunity

		would like to see changed in their community such as educational opportunities for youth, improving/growing job markets, internet broadband access, improved infrastructure, improved quality of life and a host of other issues. However, they often lack the knowledge and understanding about the interconnected nature of these opportunities and how to effectively engage in the issues of concern to their communities. Missouri Business Communities Extension has implemented significant organizational and focus changes to address the needs of our state focusing efforts on Community Economic Development, creating an interconnected unit with expertise in Workforce Development, Local Government/Public Policy, Business Development, Community Engagement, Regional Economic Development, and Ag-Business Development. The field of Community Development is rapidly changing with emphasis shifting to the building of engaged networks of citizens, organizations, and Extension personnel, and is being addressed by the CES reorganization. Community Economic Development – County Engagement Specialists have continued to engage Missouri counties (61) through the Connect Strategy, completing data profiles, stakeholder interviews, and developing issue statements (41) of local needs in Missouri communities. Identifying the following issues as common to our citizens: Workforce, Leadership & Cooperation, Infrastructure, Place-making, Economic Development, Equity, and Health. Over 43,800 direct contacts were educated in leadership, business/ag-business, workforce, and regional economic development programs (52) and conferences, workshops and courses were held (2069) to develop the individual capacities of people to effectively participate in their	

		communities and embrace leadership opportunities. Plans were developed with communities, businesses, and organizations (27) to help identify key issues and organize effective responses and new organizations were created (36), 8,428 jobs created and over 9,750 jobs retained, to leverage resources in the community and provide opportunities for new leadership to emerge. Business and Communities Extension clients reported leveraging 1,270 volunteer hours valued at $30,429, increased resources leveraged for their communities of over $1,500,000. MU Extension faculty collaborated on the Connecting Entrepreneurial Communities—Multistate Showcase. A virtual conference focused on strengthening regional entrepreneurial networks, hosted in collaboration with seven other states' University Extension programs (Michigan, Minnesota, Nebraska, North Dakota, South Dakota, Pennsylvania, and New Hampshire). Over 90 Missouri citizens participated, with 314 total participants from 28 states. Missouri faculty hosted or co-hosted three sessions of 43 total sessions. https://sites.google.com/umn.edu/cecmultistateshowcase/home In another example, MU Extension faculty partnered with the U.S. Department of Labor and other legal experts to develop and present a continuing education series on labor and workforce issues stemming from the COVID crisis. Over 40 partners collaborated on 9 sessions serving 258 Missouri participants. In 2020 the long-standing Neighborhood Leadership Program, a collaboration between MU Extension and the University of Missouri St. Louis, was redesigned to utilize a virtual delivery mode	

	Missouri Small Business Development Program **Missouri Small Business Development Center for Agriculture, Food and Forestry**	and expanded to a statewide offering. Regional cohorts of participants (540) were organized and facilitated by County Engagement Specialists across the state with educational content provided by (10) Zoom conference meetings. Evaluation responses were strongly positive with specific focus on engagement and collaboration with student projects to serve the community. Missouri businesses have leveraged $157,431,697 in loans and investments, increased sales by $621,050,359, secured contracts of $603,588,417, and been awarded SBIR/STTR grants over $1,725,000. In 2020, the Missouri Business Development Program advanced rural access to resources and education for technology companies throughout the state. Through a defined strategic plan, the BDP has expanded offering training to rural businesses through online video conferencing. Business owners, innovators, and researchers were able to attend the events at their local centers to ensure reliable connectivity. In another effort to reach a more rural audience, the Missouri Small Business Development Center (SBDC) for Agriculture, Food and Forestry has been established as a new partnership between Missouri SBDC and MU's Agricultural and Environment Extension Program working to double the value of Missouri agriculture by 2030 and already seeing positive results. The recent COVID-19 pandemic has revealed how important local meat processors are to all Missourians. When large processors across the country had to shut down and meat availability came into question, small processors across the state were inundated with processing requests. Our new center quickly put together a rapid response	

		team to help identify, engage, and provide technical assistance to over 35 processors across the state, helping them leverage Extension resources to navigate business expansions, increase meat processing capacity and increase direct marketing opportunities for Missouri's livestock producers. In 2020, COVID-19 disrupted every aspect of Missouri's economy, including agriculture. The Missouri SBDC for Agriculture, Food and Forestry, established through funding from the CARES Act, is a collaborative response to that disruption. The center is a partnership that brings together the business knowledge and resources of the Missouri SBDC and the research-based, agriculture-specific knowledge and tools of MU Extension. Counselors and specialists provide agri-entrepreneurs with personalized assistance and access to resources, financial and other, they may not otherwise easily acquire. This combination of expertise ensures that agribusiness owners have access to both the technical production knowledge and the business and marketing plans and capital to make their business successful and profitable.	
	Business & Communities Extension Program	In FY20, the Business & Communities Extension program worked collaboratively with 206 communities, 61 Missouri counties, and 291 additional partners to foster economic development and create sustainable communities and quality jobs through programs in regional economic development, business/agri-business, workforce development, and community engagement. Results reported included:	

		• $621.05 million in increased sales and $603.58 million in government contracts secured by Missouri businesses • $3.55 million in grants and other resources or efficiencies acquired by communities and organizations • $157.43 million in loans and investments secured by Missouri businesses • $1.73 million in SBIR/STTR grants • $30,429 in volunteer hours generated by B&C Extension to conduct programs • 85 participants reported taking on new leadership roles • 27 community, business, and organizational plans developed • 33 community and organizational policies/plans adopted and/or implemented • 2,121 community/organizational programs and activities initiated or completed • 8,428 new jobs created and over 9,750 jobs retained • 33 new organizations created • 27 scholarly publications produced	
2.	**Missouri 4-H**	The MU Extension has set a goal for sixty percent of adults to have a certificate or degree by 2025. According to the Missouri Economic Research and Information Center, Missouri employers report they are experiencing employee shortcomings in areas such as work habits, communication, problem solving, and teamwork (soft skills). Missouri 4-H has committed to increase engagement with students by providing educational opportunities while also introducing them to the university and the value of higher education. Our goal is to bring more youth to campus. We will do this through coordinated initiatives connecting school	Educational Attainment

		outreach and resources, educational experiences for youth, educator professional development, college and career readiness events and conferences, and holistic youth development approaches. We are partnering with other universities to bring proven educational programming to our families. Missouri 4-H is taking a two-fold approach to college and career readiness to provide educational opportunities for youth while we introduce the value of higher education. First, college and career readiness pieces are woven into our regular programming, even at the youngest ages. This can be as simple as discussing possible careers in enjoyed project areas and by working on soft skills, such as interacting with others and learning to express ideas. Having trusted adults share about their careers and the education needed to be successful, helps solidify in a youth's mind that further education will be needed to reach many of their career goals. By introducing these topics early and often, we are paving the way for our youth to find their spark and acquire the skills needed to be successful in their future.	
	4-H Youth Futures: College Within Reach	Secondly, we offer Missouri 4-H's Youth Futures: College Within Reach, a program designed help vulnerable and underserved high school students work past barriers to post-secondary education in an Ecological Systems framework. Through ongoing mentoring, family engagement, and an annual conference, Youth Futures makes college an attainable goal for high school youth who are not typically encouraged to attend college. Showing youth what colleges and technical schools can offer, how to apply for financial assistance, and completing college applications are all part of the mentoring process. The conference, held on the MU Campus, gives	

		students a taste of college life in addition to workshops, tours, and presentations. Beginning in 2020, Missouri 4-H placed a stronger emphasis on college and career readiness throughout its programs. 4-H faculty devote 20% of their time with local youth to prepare them for life after high school and explore postsecondary opportunities, including trade schools, community colleges and four-year colleges. To aid in this, we developed a six-week Youth Futures College and Career Readiness SPIN club curriculum which will allow the program much farther reach. The curriculum was designed to help 4-H faculty, staff, partners, and volunteers implement successful programs that help prepare youth for college and the workforce. We are also implementing the Juntos 4-H program that will help Latino youth (grades 8-12) and their families to gain the knowledge and skills they need to bridge the gap between high school and higher education. Through Missouri 4-H's programming in the college and career readiness, youth begin exploring careers they might enjoy at an early age and learning the soft skills needed in the workplace. As a result of the Youth Futures program, many youth who would otherwise be overlooked are given the support they need to succeed. By expanding this program and bringing in the proven Juntos program, Missouri 4-H will be capable of reaching more youth than ever before. By helping to breaking down communication, financial, and educational barriers we are offering Missouri youth a greater future. These college and career program offerings also provide opportunities for adult growth and experiences through Family Engagement events. These	

		opportunities provide the adults or caregivers to also learn what their children are experiencing and how to provide support. By educating caregivers, this provides another opportunity for encouraging enrollment growth in higher education institutions and providing the Missouri workforce with more prepared workers. In 2020, Missouri 4-H Youth Futures College Within Reach had to make some modifications due to the COVID-19 pandemic. All college tours were cancelled, the FCS Internship opportunity was postponed, and the Annual YF Conference had to minimized and held virtually. At the local level, all sites continued to operate but moved to virtual programming. Sites found it harder to keep youth and families engaged but used innovative virtual methods such as Jeopardy or virtual college tours to stay connected. The Annual Conference was condensed to three virtual days rather than 4 days on campus, and consisted of guest speakers on college preparedness, the Missouri College Advising Corps, past program participants currently enrolled in college, and college finances. We also added a weekly addition titled "So You Wanna Be A…" which showcased various colleges and departments on the campuses of MU and S&T, as well as college majors and career possibilities. Both of these (the conference and weekly additions) were open to all 4-Hers across the state and to all grant funded 4-H Youth Future sites from other states. We continued to operate sites in Kansas City, the St. Louis area (three sites), Jefferson County, and Sikeston. Four of these sites were grant funded by either the 4-H National Mentoring Program grant or by the CYFAR grant.	

		• 406 total youth (grades 9-12) • 38 graduated from high school • 35 of the 38 attended college • 1 entered the Missouri Options Program (was enrolled in an alternative school) • 2 entered the workforce • 13 previously enrolled youth graduated from college	
3.	**Stay Strong, Stay Healthy: Understanding and Expanding the Benefit of Resistance Training for Older Adults**	Age-related declines in muscle strength, flexibility, and balance are key factors for falls, the loss of independence, and growing health care costs. The Stay Strong, Stay Healthy (SSSH) resistance training program, published by MU Extension in 2005, has been shown to significantly improve muscle strength, flexibility, and balance in older adults of all ages and fitness levels. Unfortunately, in the US, less than 20% of older adults meet weekly recommendations for resistance training, so access to programs like SSSH is a pressing issue. In order to help older adults in Missouri and across the nation, SSSH is needed to accomplish two goals. First, create a team to research how much SSSH helps older adults and second, to better understand if there are areas where SSSH and be improved and expanded to provide the greatest benefit to our local communities, state, and nation. In 2019, the SSSH team connected with researchers from the Missouri Orthopaedic Institute and the MU Department of Physical Therapy to assess if SSSH is better than other forms of exercise. This work resulted in published research showing that just 8 weeks of resistance training in the SSSH program improves lower body strength and sleep quality more than	Healthy Futures

		walking for 8 weeks. Additional research since that time has also shown SSSH participation improves mental and emotional wellbeing, fall risk, and self-confidence. Perhaps the most exciting aspects of this published research were the benefits to improved muscle strength and fall risk were nearly uniform across age groups and between those who reside in rural areas vs urban areas. After reaching the first goal, demonstrating the efficacy of the SSSH program, the second was to understand access barriers. Many Missourians live in rural areas that pose unique financial and technological challenges to participating in programs like SSSH. This lack of access only further exacerbates the large health discrepancies our rural populations face compared to their urban neighbors. To break down these access barriers, virtual classes have been offered for nearly a year allowing folks to take the classes, gain muscle strength, and safely socialize during the COVID-19 pandemic. Additionally, it has allowed more individuals to participate without having to arrange transportation, a key barrier to many older adults. Something important to consider is that although the virtual classes work, they are only beneficial if the participant has the capability and knowledge to use technologies required for virtual SSSH delivery. In a recent grant proposal to the National Institutes of Health, the SSSH research team has outlined a clear 5-year plan for how to increase SSSH programming in rural communities that will allow nearly a 300% increase in Missourians with access to the program. If funded, this project will become the foundation for rural SSSH implementation not only in Missouri but in other states that currently utilize the SSSH program such as rural areas in Nevada, Tennessee, Kansas, and North Carolina.	

		A comprehensive body of research is necessary before the term "evidence based" can be applied to any program. In 2020, SSSH was added to the USDA SNAP-Ed toolkit as an approved research-tested evidence-based intervention. This designation confirms efficacy and allows other agencies to use federal funds to adopt SSSH. SSSH is currently completing a review process to determine if it meets the Administration of Community Living's (ACL), a division of the U.S. Department of Health and Human Services, evidence-based program criteria. In summary, we have created an evidence-based resistance training program that is affordable, accessible, and highly beneficial to a large proportion of older adults. In the next 12 months, our team will continue to find ways to improve access to the SSSH program across multiple states and research the efficacy of different SSSH iterations with the ultimate goal of helping as many older adults as possible lead healthy and independent lives. Due to COVID-19, Stay Strong, Stay Healthy (SSSH) had to quickly pivot to a virtual delivery format in 2020. Virtual SSSH delivery was tested in the summer utilizing a team-teaching approach: a lead instructor, safety spotter, and technical assistant. The SSSH leadership team provided virtual delivery training for instructors in Missouri, Kansas, North Carolina, and Tennessee. Virtual SSSH courses launched in the fall, reaching 27 participants in Missouri. Virtual courses are unique because they are not limited by geography, thus individuals from various counties were able to participate in the same virtual SSSH course.	

		Missouri instructors were able to offer local face-to-face courses in early and late 2020 while following local social distancing guidelines. In total, 289 older adults participated in SSSH courses offered by trained instructors. Participants' average age was 73 years, 250 were female and 38 were male (1 no response). As a result of SSSH in Missouri, 90.63% increased knowledge of strength training, 75% increased the amount of weight they used during strength training exercises, 98.95% felt their overall health improved, 96.91 felt physically stronger, 73.63% indicated their joints felt better, and 74.23% felt confident to continue strength training exercises on their own.	
	COVID-19 Ag & Food Safety Response Effort	Farmers and other agricultural workers were considered essential under Missouri's 2020 COVID-19 stay-at-home order. However, agricultural workers faced some unique risks that other sectors did not. For instance, family farming operations often have multiple generations of workers sharing the same equipment. This increases the chances of a high-risk individual contracting the virus. To ensure individuals were safe on the job, Extension specialists formed rapid response teams, held virtual town halls and webinars, modified other classes and events to online formats, and created free publications on COVID-19-related farm and food safety practices. Specialists also worked to translate materials into Spanish and French to be inclusive of all Missourians who needed the information. All these efforts allowed for the continued dissemination of Extension's valuable expertise while including information that would help mitigate the risks of COVID-19 infection among agriculture sector workers and consumers alike.	

4.	**Institute for Social Justice and Educational Empowerment**	Because many Extension programs have aspects of social justice from food justice to criminal justice, we are establishing an institute of social justice. The purpose of the Institute for Social Justice and Educational Empowerment (ISJEE) is to educate constituents on how to increase their awareness towards accessing quality resources. In addition, ISJEE will assist them on exploring and assessing their reach regarding information relating to the insurmountable challenges being applied regarding social justice vs. injustices for people living with limited financial resources and underserved audiences. The vision is to advocate, empower and promote the application of change by offering social justice solutions through education to enhance and increase equal access and community empowerment. The mission is to offer research based educational programs and services to Missouri's hard-to-reach citizens by providing resources, tools and information to stimulate avenues of hope.	Social Justice
5.	**Environmental & Natural Resource Research** Soil health • Phosphorus forms, availability, and microbial biomass dynamics in soils of organically managed farms in Missouri	The concept of microbial enhancement of phosphorus (P) availability to plants is known. However, under organic farming, it is crucial to develop management strategies that enhances microbial activity for continuous mineralization of organic-P to sustains P fertility for maximum plant growth and development. Phosphorus resources in nature are limited, and its availability affected by adsorption and fixation in soil. As predicted by agronomists, the supply of P will limit increases in agricultural production in forthcoming decades, specifically under organic production. Organic systems rely on reserves of soil phosphorus built by the mineralization of organic residues through microbial activity or application of rock phosphate, which is very slow in releasing the needed P into the soil. There is a need to reassess allowable P inputs in organic farming systems to	Environmental and Natural Resources

	• Cover crop and animal manure management impacts on soil active organic matter and agronomic performance	improve overall long-term sustainability. Therefore, it is necessary to identify proper sources for phosphorus and the contribution of the microbial community to the mineralization of organic sources be investigated. This project is to assess to what extent farming practices affect the soil health and accumulation of the total and available P in selected small organic farms in Missouri. Specifically, the concentration of total, inorganic, and organic P will be determined. Inputs and outputs will be determined. The enzymatic activity of microbial communities critical for cycling of P in ecosystem will be investigated. Results would have major impacts on the design of fertilization program and development of best management practices for organic small farmers. Due to costs associated with synthetic chemical fertilizers and pesticides, farmers -especially limited-resource farmers – are often looking for ways to reduce cost, increase yield, and/or increase value of agricultural products. One potential option is through organic production that can provide both environmental and agronomic benefits. However, weeds and soil health/nutrient management are major limitations for organic producers. In Missouri, organic producers have shown high interest in managing soil nutrients and weeds with cover crops. Though cover crop benefits to soil health including carbon sequestration is widely recognized, their relative impacts on agronomic performance are not well-documented. This research is to investigate factors that support sustainability in organic vegetable production. Primary objectives are to: i) evaluate how cover crop residue type and organic soil amendment application method affect soil properties that support microbial activity, nutrient availability and hence plant productivity; ii) evaluate the effects of cover crop residue type and organic amendment application method on	

		agronomic performance as measured by marketable vegetable yields; and iii) assess how cover crop residue type and organic amendment application method affect weed species and densities. This work will provide much-needed data to address existing knowledge gaps in our understanding of the relationship of soil health and the active-pool organic matter in particular with plant productivity in organic agroecosystems, linking between soil health and plant productivity across a wide range of soil types and climatic gradients in Missouri and beyond. Farmers of the 21st century are faced with a daunting challenge, meeting the food, fuel, and fiber needs for rapidly growing human populations, while at the same time minimizing excessive soil erosion and nutrient pollution, especially under climate change. Organic farming and agroforestry BMP's are on the rise due to their social, economic, and environmental benefits. There is a critical need to directly assess the outcomes of USDA recommended organic farming and agroforestry BMP's to ensure time, money, labor, and raw materials are not wasted. This research aims to use state-of-the-art instrumentation to monitor climate extremes, directly measure the outcomes of BMP's at strategic locations (i.e. study sites) within an agricultural watershed. There is a strong focus on comparing the outcomes of organic farming and agroforestry BMP's relative to conventional farming practices. Soil erosion and nutrient pollution will be directly measured from water samples collected at three farms (including Missouri's largest certified organic farm) and nearby streams. Results will be used to provide farmers and managers with science-based information and tools (i.e. tested/verified models) needed to meet the food, fuel, and fiber needs of rapidly growing human populations, while at the same time minimizing excessive soil erosion and	

		nutrient pollution. Ultimately, results will be useful for developing effective regional management plans to protect social well-being (i.e. quality of life), economic growth, and environmental health.	
	Water Quality • Measuring and modeling influences of hydroclimate, land use, and best management practices on water quantity and quality in Central US • Developing Mg-Al double layered hydroxides impregnated granular activated carbon for disinfection byproducts control and rural drinking water improvement	Drinking water safety, especially in rural community or small water systems, is becoming public health and environmental concerns. Elevated toxic disinfection byproducts (DBP), heavy metals, and pathogens in drinking water have been reported to threaten public health. Controlling toxic disinfection byproducts (DBPs) has become a major challenge facing small, rural drinking water systems, due to the USEPA Stage II DBP drinking water regulations and limited technical resources. In an effort to improve drinking water safety and safeguard human health in rural community, the understanding of the mechanisms of DBP formation and the development of cost-effectiveness control technology based on DBP formation mechanisms are critically needed. This study is to i) develop Mg-Al DLH impregnated GAC composite adsorbate with high removal efficiency for bromate/bromide; ii) investigate the removal mechanisms of bromate/bromide under drinking water treatment conditions and quantifying the adsorption process; and iii) develop conceptual treatment process for the application of the optimized composite materials for bromine-related DBP mitigation. Findings from this research will substantially advance our fundamental understandings of bromine related DBP formation mechanisms and develop highly efficient composite adsorption materials (Mg-Al CLDH impregnated GAC) for bromine-related DBP control. Outcomes of the project would substantially improve drinking water quality for rural community, help small water systems in compliance with the EPA regulations, and safeguard human health of rural residents from water contamination.	

	• Mercury, selenium, and other trace elements in largemouth bass (Micropterus salmoides) from large Missouri reservoirs	Fish are an important addition to the human diet because they are an excellent source of nutrients. As a result, the American Heart Association recommends two servings of fish per week as part of a healthy diet. Despite the health benefits of eating fish, toxic elements (e.g. As, Cd, Hg, Pb, etc.) pose potential risks to consumers. These elements derive from both natural and anthropogenic sources. The major drivers of metal(loids) to lakes and biota include landscape, atmospheric deposition, and runoffs. In Missouri, the Department of Health and Senior Services (DHSS) recommends that women and children under 13 years consume no more than one meal per month of large-bodied predatory fish species that have the highest mercury (Hg) concentrations. However, there is minimal data on the concentrations of other metals in fish in Missouri Reservoirs. The objectives of the project are to 1) determine the trace elements (Hg, Se, As, Cd, Pb, Ca, Zn) in largemouth bass from five Missouri Reservoirs and the relationships with size/age of fish; 2) describe the relationship of Hg with other metals; 3) understand trophic interactions and Hg transfer through stable isotope (δ 15N, δ 13C) studies of composite food chain samples; and 4) investigate lake water chemistry to understand the influencing variables to metal transportation. This work is to address knowledge gaps from previous studies by the MDC and the DHSS and will support stakeholder engagements in water quality, food chain studies, and policy on ecological risk management of Missouri reservoirs.	
	Forestry Ecosystem • Mapping the effects of silvicultural management and climate change on	About 35% of Missouri's total land area is covered with forests (6.2 million ha). These forests provide critical economic and life support systems and harbor a rich diversity of wildlife. However, disturbance impacts on Missouri forests are increasing. Mortality is increasing and net growth is	

	Habitat Connectivity and composition in Missouri Ozark forest landscapes	slowing down. Disturbances includes increased utilization due to increased demands for wood and other forest products, unplanned development and conversion of forests to other land uses causing fragmentation and isolation of species habitats, and more recent increases in invasive plants, insects, and pathogens. The goal of this proposal is to monitor the effects of both microclimatic changes and management treatments on the diversity of habitat structure, connectivity, species composition, and hence biological diversity by generating high resolution climate grids. The four specific objectives are: 1) perform landscape structure and connectivity analysis of Ozark Forests identifying the fragmentation hotspots and the connecting steppingstone zones for wildlife species. 2) produce high-resolution climate surfaces of Ozark forests accounting for microclimatic change effects on structural connectivity changes. 3) map the effects of three silvicultural treatments on habitat structure and connectivity, 4) analyze the effects of climate change and management treatments on composition and biodiversity indices using bioclimatic niche modeling. Spatially explicit connectivity analysis will help Missouri Department of Conservation in locating Forest Opportunity Areas and Conservation Opportunity Areas, both of which refer to the high priority or best geographic locations for allocation of limited conservation funds to result in highest "payoff". Areas of high connectivity are considered to be favorable for a larger number of species in a habitat-based conservation approach. Connectivity analysis will help effective planning of new residential or commercial development by locating and avoid destroying the critical areas.	
	Utilizing small unmanned Aerial vehicle imagery to investigate	The invasive insect pest, emerald ash borer, infects and eventually kills ash trees and is currently spreading across Missouri. The emerald ash borer	

	emerald ash borer infestation in Central Missouri	(EAB) infestation was first detected in Missouri near Lake Wappapello, Wayne County in 2008. It has since spread to eighty-seven Missouri Counties. Early detection of emerald ash borer (EAB) infestation is critical to managing the spread of this pest through biological or chemical control. Small-unmanned aerial vehicle (sUAV) or drone-based studies will be used to establish a remote sensing-based approach for mapping ash trees and assess EAB infestations. To accomplish this, sUAV/drone images will be collected over targeted EAB infested sites. The data will be processed and field verified. The research work is anticipated to produce sUAV data-based procedures that can be used to identify ash trees, map and assess the severity of EAB infestation in forest stands.	
6.	**Animal Research** Small ruminants • Evaluation of lean meat selection efficiency and response in Katahdin sheep • Feasibility study examining nanoparticle purification of ram semen for improved artificial insemination	Increased consumer's concern of health aspects has led to demand meats with a higher ratio of lean-to-fat tissues. The demand of sheep meat that supplies high quality protein has been recently increased. Application of Ultrasound Scanning in sheep marketing and selection could help improve the selection efficiency, speed, and accuracy for breeding methods as well as shorten the breeding interval and generation length. With this technology, sheep producers are able to select animals based on leaner muscle and lower fat content carcass predictability without any invasive assessment of animals. This study is to conduct lean meat selection in Katahdin sheep, evaluate lean meat selection efficiency, enhance lean carcass quality traits, and increase sheep farming profitability. Developing a lean sheep selection index could improve breeding efficiency, selection response, and genetic progress in meat yield and quality characteristics. This study is to evaluate a nanoparticle-based magnetic purification method that removes defective and/or prematurely capacitated spermatozoa from ram semen prior to cryopreservation. The utilization of this nano-purification technique will improve fertility there by allowing for a 50% reduction in semen used for artificial insemination. To accomplish	Sustainable Agriculture

		this goal, the presence of proven negative biomarkers on ram spermatozoa must first be validated. Then using the most apparent negative biomarkers, construct coated nanoparticles with antibody or lectin probes and analyzes the sperm fractions using a flow cytometer to determine the success of nanoparticle-purification. Finally, the purification technique will be applied to ram semen used for artificial insemination, cryopreservation, and in vitro fertilization. Once the nanoparticle purification procedure is successfully optimized to the sheep production system, the technique should allow farmers in the field setting to better assess ram fertility prior to freezing for artificial insemination or use for natural mating.	
	• Effects of creep feeding or creep grazing on the performance of sheep organically raised	The increased demand for organic meat products has attracted producers to convert from conventional farming to organic; however, there are limited data about lamb meat organically produced. This project is to develop best practices for organic sheep management on pasture to increase the level and efficiency of organic sheep productivity and profitability from sheep production. Adequate nutrition and good management are essential to promote animal health and optimize growth rates in organic farming system. Creep feeding is a management strategy to provide supplemental nutrients to livestock during the pre-weaning phase. Creep grazing is another management option, which aims to provide higher quality forage to suckling livestock. The addition of legumes in grass-based pastures for creep grazing area would promote an increase of the overall nutritive value and a better quality feed of the pasture for small ruminants organically produced. The combined benefits of high crude protein content can make forage legumes potentially attractive as a natural means of increasing live weight gain in lambs. In Missouri, alfalfa and red clover are the most common legumes used by small ruminant producers to improve their pastures. Providing these legumes in a creep grazing area to increase pre-weaning growth performance of lambs.	

	Poultry • Feasibility study: Use of heritage breeds for pasture-based poultry production on small farms	There is a rapidly growing market for specialty poultry production using alternative genotypes and management systems for small- or medium-sized producers. This research is to examine the feasibility of using heritage breeds in profitable and sustainable pasture-based poultry production on small farms. The objectives of this research are to 1) identify common production practices used and challenges faced by small-flock poultry producers in Missouri, 2) evaluate the suitability of dual-purpose heritage breed chickens for small-scale, pasture-based egg and meat production, 3) evaluate the use of mobile and day-range pastured poultry models for egg production, and 4) determine consumer acceptance and willingness to purchase heritage breed chicken meat. Results can be used to develop a model to help small-flock producers make economic and agribusiness management decisions regarding the profitability and sustainability of using heritage breeds in pastured poultry production systems. This research will also produce guide sheets, conduct demonstrations, and provide training to producers on small farms. Additionally, because heritage breed chicken meat differs from conventional chicken meat in both flavor and texture, Outreach efforts will be made to introduce consumers to heritage breed chicken meat develop guide sheets with cooking instructions and recipes to highlight heritage chicken breeds.	
	Aquaculture • Integration of production systems for food-fish	Seafood is an important contributor to the US trade imbalance. Entrepreneurial Missouri farmers on food-fish production have potential for offsetting the imbalance. Missourian entrepreneurs in food-fish production need vetted approaches suited for resources that are available and affordable. Survey indicated that farmer's confidence can also be lacking without experience in technical and regulatory challenges associated with food-fish operations. The limitations can be overcome through approaches targeting shortened temperate climate production cycles and providing higher quality products at a lower production cost. Rainbow Trout and Bluegill are produced by farmers supplying the	

		recreational fishery stocking market. Despite these species being valued as food-fish, markets based on these species have yet to be supplied by farmers. This project aims to 1) improve culture conditions for Rainbow Trout produced in a hybrid recirculating / flow-thru aquaculture system, 2) shortening of black bass production cycles by coupling indoor over-winter recirculating aquaculture system (RAS) rearing of fingerlings with warm season pond growout, and 3) providing farmers with a selected Bluegill stock for performance as food-fish when fed a closed formulation made from locally sourced feed.	
	Plant Research Specialty crop • Optimizing production practices of nutrient-rich leafy green quinoa under field and high tunnel environment	With consumer's health concern, the demand of healthy, nutritional foods is increased. Consumption of nutrient-rich quinoa leaves as leafy-green healthy vegetable is not well known to general public. Quinoa is drought, heat and salinity tolerant, and requires less water and fertilizer to grow compared to most of our traditional leafy vegetables. It is summer vegetable but can be grown year around in the field, greenhouse, or high tunnel and normally is harvested in 4-5 weeks. In compared to spinach and other greens, vegetable quinoa contains higher amounts of protein, lower carbohydrate, a full array of essential amino acids, and higher amounts of essential mineral elements. This project is to introduce leafy green quinoa to consumers and vegetable growers and to increase their farm profitability through the cultivation of this new vegetable. The objectives are, to (1) evaluate and select best quinoa lines for vegetable production and optimize leafy green quinoa production in the field during summer, (2) optimize leafy green quinoa production in the high tunnel for season extension, and (3) disseminate vegetable quinoa production technology and encourage adoption by small farmers as a profitable vegetable crop. Findings will be disseminated to vegetable growers through outreach activities, such as demonstration plots, workshops, field days, farmers markets and production guide. Generated information will promote production of new and specialty leafy greens, increase grower's incomes, and promote a healthy local food system.	

	Horticulture • Investigation of the effect of soil fertility and crop cultivars on the concentration of mineral nutrients in organic food crops	The importance of organic food crops resides in their benefits to health of people, soil and the environment. While human health benefits associated with low pesticide residues on organic crops, air and water have been addressed, the link between organic agriculture and nutritional quality of crops is yet to be considered. In addition, while much research has addressed pest management in organic agriculture, minimal emphasis has been given to soil fertility management in organic soils, and nutrient concentration in organic crops. This project is to evaluate crops with different phenotypes and genotypes, heirloom and modern for nutritional quality and for response to different organic fertility practices. Outreach activities (on-farm research, farm demonstrations, presentations at growers meetings, field days, and annual professional meetings; and articles in newsletters, websites and referred articles) will be used to disseminate results to Missouri farmers. Advisory panels of organic growers, faculties and USDA representatives will be engaged in the research and outreach activities in the project and participate in the monitoring and evaluation of the project.	
	• Nutrient management in sustainable small-scale hydroponic systems: yield and quality response of specialty and exotic leafy vegetables to nutrient solution nitrogen composition	Unstable produce prices, the dominance of the market for traditional commercial horticulture crops by larger farms, and the reduction of government price stabilizing tools threaten the viability of limited resource farm enterprises in Missouri and the NCR. Hydroponic production of specialty crops under greenhouses and other protected structures provides an alternative approach to field production and conventional greenhouse crop production, which is often constrained by good seedling stand establishment of warm season crops, limited control over adverse weather, pests and diseases. Hydroponic systems can potentially increase opportunities for year-round production, ensuring a steady market supply of high-quality fresh produce and continuous cash flow for the grower. This project will focus on evaluating specialty and exotic leafy green vegetables, culinary or medicinal herb cultivars in a nutrient recirculating hydroponic system. Objectives are to determine nitrogen nutrition requirements and appropriate composition of nitrogen in the hydroponic	

		nutrient solution for optimum marketable yield and quality of specialty and exotic leafy vegetables, culinary or medicinal herb species, and develop science-based cultural practices with practical application in managing crop nitrogen nutrition in small-scale hydroponic production for limited resource growers in Missouri and the NCR.	
	IPM • Implementation of surveillance and early detection of the invasive brown marmorated stink bugs in cropping systems in Missouri	Small-scale, low-income and under-served vegetable and small fruit growers in Missouri have inadequate capacity to deal with the numerous challenges they face during crop production. This research is to develop strategies to address the inadequate pest management needs and develop ways to disseminate current research results to small-scale vegetable and small fruit growers, with focus on 1) state-wide program for early detection and surveillance of invasive insect pests; 2) development and fine-tuning of existing IPM programs; and 3) pest monitoring and predictive models to provide timely information on pest emergence, seasonal abundance and damage. The research will have a potential impact on more than 1000 under-served, low-income small fruit and vegetable growers in Missouri with measurable outcomes such as improved awareness about invasive pests and knowledge on how to manage them.	
	Industrial hemp • Identifying causal organisms of new and emerging diseases of industrial hemp and disease-resistant varieties in Missouri	Missouri Department of Agriculture has approved more than 154 producers to legally grow hemp in Missouri in 2020. However, knowledge of hemp diseases among producers is extremely limited. The goal of this project is to determine new and emerging diseases of industrial hemp in Missouri, identify causal organisms, and examine resistance and susceptibility levels to the diseases among the commercially available industrial hemp varieties. Specifically, we will collect suspected diseased hemp plant samples from two Lincoln University farms to identify diseases and their causal organisms using laboratory techniques and greenhouse experiments. We will conduct field trials to determine resistance (or susceptibility) in the commercial hemp varieties. The project will generate information on new hemp diseases in terms of disease symptoms, their	

		causal organisms, and a list of susceptible and resistant varieties to the diseases, which will be significantly useful to protect hemp plants in Missouri. Also, research findings will be disseminated to stakeholders including producers, plant pathologists, and extension specialists.	
	• Industrial hemp capacity research	Industrial hemp has been identified as a potentially valuable and impactful alternative crop for Missouri. To support the future viability and sustainability of a hemp industry, preliminary assessment of the crop and cropping systems and necessary education and training aspects must be established prior to commercialization. Missouri House Bill 2034 gave approval for a research pilot program in 2018, and Senate Bill 133 allowed industrial hemp to be produced commercially as of June 2019. Given the potential opportunities and challenges. This project is to support the growing practices and future commercialization of industrial hemp. The pilot project will address overarching questions about plant growth conditions, varietal selection, management practices, disease control, farm infrastructure, education and economic impact to foster a profitable and sustainable hemp industry in Missouri, contributing to national and international markets.	
	Plant genomics • Molecular tools and translational genomics for improving genetic gain in selected legume crops	Legumes play a critical role in ensuring global nutritional food security and improving soil quality through nitrogen fixation. Legume production increases have mostly been due to increases in the land area planted. This clearly suggests the need of developing new legume varieties with resistance to the major stresses, especially in the context of climate change. The genome sequencing technologies are becoming more cost - effective and have introduced next generation genomics and breeding by precise identification of genes and haplotypes associated with distinct phenotypes leading to the selection of plants based on genotyping information. This research will develop key genetic resources for selected grain legumes, both specialty crop legumes and other legumes. Natural genetic variation for early seedling vigor and increased water and nutrient (e.g., N, P) use efficiency traits (key root system traits) that improve crop	

		productivity and seed composition will be targeted. Small farmers will be highly benefited with the newly developed legume crop germplasm/varieties for crop resilience and sustainable agriculture. The project outcome including the value-added selected legume crops will complement and enhance the Missouri agricultural production and economy.	
	Ag Economics Research • Value chain of Missouri local and regional food system and roles of producers' organizations	The economic resilience of local and regional food systems is important to the economic well-being of the rural community, small and medium-sized producers. Policymakers at federal and state levels have made great efforts to develop local and regional food systems, through which to increase food security and access to healthy food and promote rural development. Since 2002, Farm Bills started to include legislations for the local food system. The 2018 Farm Bill has many titles to support and expand local and regional food systems. The USDA created several programs to implement the Farm Bill policy and to increase the availability of locally produced agricultural products, such as the Farmers Market Promotion Program, Local Food Promotion Program, and Regional Food System Partnerships. Agriculture contributes more than 88 billion dollars to the state of Missouri. Missouri is one of the states promoting the local food system and has established the Missouri Grown program and Buy Missouri program. The overall goal of this study is to understand consumer and producer characteristics of Missouri local and regional food systems, evaluate the impacts of the Missouri Grown program, and develop policy recommendations and strategies for expanding and improving local food systems to meet specific challenges.	
	• An economic and market evaluation of the potential for production of sweet potato and watermelon in southeastern Missouri	Producing the traditional crops such as soybeans, corn, wheat requires large amount of resource and involves high cost. This has left small-scale producers unable to compete profitably with the large-scale commercial producers. Moreover, research conducted in the State focuses on the needs of the large-scale commercial producers. As a result, small-scale producers are to seek alternatives to the traditional crops. Horticultural	

		cash crops are most attractive to small-scale producers because the crops produce high returns per unit land area. In addition, small-scale producers can get good returns from diverse horticultural crops on a small land area and do not have to compete with the large-scale commercial producers. Two such horticultural crops are sweet potato and watermelon. Sweet potato and watermelon are warm weather vegetables that are mostly produced in southeast Missouri. The importance of alternative crops and other alternative sources of income and profits for the small-scale and disadvantaged farmers could mean the difference between success and failure for farmers. The overall goal of this study is to conduct an economic and market studies of sweet potato and watermelon production in southeast Missouri, in order to provide research-based information to producers. The specific objectives are: 1) conduct a market window analysis in the St. Louis and Chicago terminal markets of sweet potato production in the Bootheel region; 2) estimate the demand relations of sweet potato in the St. Louis and Chicago markets; 3) to evaluate the economic efficiency of sweet potato production; 4) to evaluate the economic efficiency of watermelons production in southeast Missouri.	
	• Global Food Security and Hunger	All Extension programs were significantly affected by issues related to the economic, social and health impact of the global pandemic. Lincoln University's Cooperative Research and Extension programs focus on enhancing the quality of life for diverse, limited resources audiences, including low-income, limited resource farmers and ranchers, and underserved population in rural and urban communities. In addition, we also work with gardeners, commercial farms, organic and small farms, fruit and vegetable framers. Highlights	

		1. Small ruminant health and production management, poultry nutrition and production management develop sunfish cultigens for Missouri small farms. 2. Provide aquaculture fish health services for stakeholders. 3. Introduction and evaluation of new crops (including native and specialty crops) and improvement of production management practices. 4. Organic production practices for animal and vegetable production. 5. Developed an Industrial Hemp initiative, provided information to producers and law enforcement as well as developed a variety trial for Missouri farmers. 6. Promotion of backyard and community gardening. 7. Conduct analysis of the challenges of rural entrepreneurship and their impact on the prospects of community development. 8. Develop effective and environmentally and grower friendly IPM approaches to manage key insects of small fruits and vegetables 9. Soil management for building soil organic matter and improving soil health 10. Agriculture Economic and Marketing program is implementing a marketing program strategy to help limited resource producers access new markets, including online sales. 11. Conferences, meetings, workshops, and training and educational opportunities for small farms. What has been done? 1. Abstracts, publications, grant proposals, and guide sheets 2. Designed educational program for producers to access and motivate market consumers. 3. Developed linkage chain of partner groups to promote products. 4. Small minorities and undeserved farmers were educated to practice strategic planning for their business and an approach to design new business model.	

		5. Teaching individuals and communities to grow their own food reduces the threat of inaccessible, unaffordable nutritious foods and contributes to economic growth, and reduces chronic diseases. The Agriculture Economic and Marketing program developed multiple activities related to enhancing farmers' and gardeners' capacity. The Gardening Entrepreneurship program is implemented as a community development program. Several faculty and staff collaborate to offer individualized training and support communities. 6. Nine gardening entrepreneurship sessions were conducted. The program was able to outreach over 100 gardeners to enhance skills and knowledge. Mainly Three webinars to teach stakeholders about harvesting and marketing strategies to connect with consumers Issue 1. Small farmers were provided with appropriate knowledge and technologies to practice more profitable small ruminant sustainable (organic) production system. 2. Farm outputs of 30% of small farm clients increased noticeably, and their farm income increased on average, by $1,000 or more. 3. Small and disadvantaged farmers and ranchers received education and funding through various USDA programs, or other donor organizations. Fifty percent of them adopted sustainable farming practices, thus improving environmental quality of the locality. Twenty percent of small farmers reduced production risks through diversification of farm enterprises. Farm revenue increased through production and promotion of local foods. 4. Home and community gardens, farmers' markets and food hubs where established. 5. Farmers have received Good Agricultural Practices (GAPs) certification during the year. All these should augment the quality	

		of dietary intake of the population in the community, improve the environmental quality, and stimulate the local economy. 6. Lincoln University put down roots in work to develop industrial hemp as a cash crop for small farmers. Workshops, seminars and field days have been conducted to expose farmers and law enforcers to information regarding the growth of this crop. Who cares? Small, limited-resource farmers improve production and increase profits and add to the economy of Missouri. Many limited-resource, minority, socially-disadvantaged and beginning farmers have had had better access to technical advice on animal and crop production, pest management tools and strategies that are simple, effective and affordable.	
7.	**Food Safety Research** Food treatment technology • Investigation and determination of safe guidelines for Sous Vide cooking	Sous vide, a method of cooking vacuum packaged products in a heated water bath (typically below the water boiling point), has seen significant increases in interest over the past decade. But in order to develop those processes, robust scientific test must be performed. In this work, three simple questions will be addressed for a variety of whole and ground meats - Can the USDA tables be extrapolated to lower temperature, longer time cooking methods like sous vide while maintaining consumer safety? If not, what are the time temperature combinations necessary to ensure consumer safety? How will such treatments affect consumer perceptions of quality? In order to answer those questions, several techniques are needed- Cooking via immersion circulator, monitoring of internal temperature via automated system, inoculation of meat samples, determination of bacterial counts before and during cooking, and testing of the color, texture and sensory attributes of non-inoculated samples. The data generated by this study will greatly increase our understanding of the technique and allow for the development of consumer/ industry resources	Health

		such as tables of temperature/ time setting for a given degree of doneness, extension pamphlets outlining best practices, and scientific publications to further interest and inquiry among fellow scientists.	
	Detection sensor technology • An Impedance biosensing technology for rapid detection of Salmonella and E. coli O157:H7 in meat products	The food contamination of E. coli O157:H7 and Salmonella is a threat to public health. This project will develop a transformative impedance-based MEMS biosensor for simultaneous, quick detection of E. coli O157:H7 and Salmonella for meat products, such as ground meat and cube steaks, at a concentration toward 1 cell/325 gr within 4-7 hours. The technology developed by this research would help meat processors and producers detect and monitor the food contamination prior to or during the distribution process.	
	• EOT-SERS portable detector and high-throughput metabolomics methods for intelligent sensing of foodborne pathogens	The mass production and multi-channel sales of high-nutrient and fresh-cut foods increased the universality and diversification of foodborne pathogens, which could be a threat to food safety and public health. Since February 2020, the Missouri Department of Health and Senior Services (Missouri DHSS) has issued more than 70 food recalls, mainly related to foodborne pathogens such as Listeria, Salmonella, Escherichia coli, Cyclospora, mold. The higher frequency of outbreaks of foodborne-illnesses is also believed to be related to low-efficiency detection of potential food hazards. Thus, there is an urgent need for rapid detection methods to monitor food safety issues with high efficiency. This research aims to establish a rapid and intelligent food safety inspection method via on-site sensing for fast pathogen identification and backend laboratory detection for comprehensive confirmation. Expected results of this project include developing a portable detector equipped with a matrix sensor array and high-throughput UHPLC-MS/MS and GC-MS detection methods.	

	Food pathogen control • Use of endophytic micro-organisms to improve the food safety of fresh and fresh-cut produce	A database of molecular fingerprints of foodborne pathogens will be established to provide insights into the outbreak of foodborne diseases. Finding will help provide a rapid, sustainable, and cost-effective detection strategy for preventing and controlling foodborne disease outbreaks in Missouri and other States. The number of foodborne disease outbreaks associated with fresh and fresh-cut produce has increased in recent years in the United States. However, current postharvest washing and sanitization processes do not always effectively reduce pathogen contamination in/on produce, and there is increasing concern about the chemical compounds used in postharvest sanitation. Therefore, novel control methods are critically needed. This proof-of-concept project tackles the use of endophytic microorganisms for the competitive exclusion of potential human pathogens on fresh produce. Endophytic microbes are symbiotic and able to live inside plants from farm to table. We hypothesize that produce naturally carrying single or a mixture of antihuman-pathogen endophytes can safeguard in situ fresh and fresh-cut produce against potential human pathogens from farm to table. Romaine lettuce and human pathogen E. coli O157:H7 (EcO157) were selected for this study to prove the concept of the in-situ biocontrol of human pathogens in fresh and fresh-cut produce. We will first isolate abti-EcO157 from the internal tissues of lettuce and then evaluate their efficiencies on controlling EcO157 in lettuce pre- and post- harvest. Success of this project can lead to developing an environmentally sound, user-friendly, economic, and efficient biocontrol technique for farmers of produce at local, state, and national level.	

	Focus on Aging and Health	The health and wellbeing of Missouri seniors remained a focus during this reporting period as educational and socially interactive programming continued to be offered utilizing previously successful delivery systems. Educational events related to new subject matter that directly affects this demographic were executed and ongoing programs offering beneficial social engagement of the clientele were augmented. What was done: New topics were incorporated into the Lunch and Learn format providing Missouri seniors with valuable information related to health and wellbeing through online workshops. Topics covered included: seasonal affective disorder (SAD), healthy eating and staying active to minimize the effects of SAD, smoking cessation, how seniors can continue to remain influential in their communities, and how seniors can maintain emotional and social wellbeing during the isolation of a pandemic. An established partnership with the State Health Insurance Assistance Program enabled continuation of the Medicare Part D program, through which seniors are educated about prescription drug coverage under Medicare. Senior in various settings (care facilities, private homes) were involved in ongoing programming focusing on health and wellbeing. They took part in activities ranging from fitness to craft activities such as sewing and crochet, to field trips, to Spanish classes, to computer literacy and skills development programs. Outcomes: Seniors were provided access to education and were able to increase their knowledge regarding the various topics presented in the Lunch and Learn series. This increase was consistently demonstrated through the	

		administering of pre- and post-tests. Participants also generally reported improvement in quality of life and wellbeing after learning about the various topics. After being educated about the program, Missouri seniors continued to be enrolled in Medicare Part D. The group of seniors who participated in wellness programming had fewer doctor visits, had a combined weight loss of 100 pounds, and reported an increase in their quality of life and that they looked forward to each upcoming session, boosting wellbeing during a challenging year.	
	Childhood Obesity Reduction and Human Nutrition	The Issue Childhood obesity reduction and other nutrition work have been aligned with food insecurity, childhood hunger, chronic disease prevention and treatment, public health promotion and public health nutrition. LUCE has been without a nutrition specialist for more than ten years. Preliminary efforts were made to establish the specialist as a resource from LUCE. The pandemic resulted in changes in program delivery, with some programs moving to virtual platforms. The pandemic unveiled the severe issues around the need for children and families to have access to food. Highlights: What Was Done 1. Developed partners and helped identify people in need and delivered 623, 881 pounds of food and 39,906 farmers-to-families food boxes providing nutritious, good-quality food to more than 3,500 families in Missouri as well as four surrounding states. 2. Assisted with the harvest and delivery of 3,144 pounds of fresh vegetables to three distribution sites targeting limited resource	

		populations in Cole County, yielding a consumer savings of $4516 worth of fresh produce to ~ 120 families. 3. Produced 19 publications. 4. Wrote 16 articles (including 6 health promotion articles in conjunction with National Heart Month and National Nutrition Month), developed 5 program flyers. 5. Developed partnerships with more than 30 agencies, community-based organizations, and municipalities. 6. Produced 25 consumer education publications, served as peer-review for an additional 5 publications and on the NIFA review board for the Farm and Ranch Stress Assistance Network Program. 7. Developed/adapted 96 recipes for public use, especially constituents of the Farmers-to-Families Food Box program and the Salvation Army Food Bank of Cole County. 8. Assisted with 6 extramural funding projects. 9. Developed alliances with other 1890 schools to promote nutrition and agriculture. 10. Developed 6 training modules and a new-colleague orientation protocol for EFNEP staff. 11. Developed and produced 8 consumer education videos. 12. Served as conference coordinator for state-wide professional conference successfully held during the pandemic. 13. Conducted 5 series of consumer nutrition education programs in Central Missouri Results: Program initiatives were aimed at helping individuals and communities to take action on policy issues that affect good food accessibility and growing	

		food demands, by addressing food security for vulnerable populations. Since food is a prerequisite for health, and the lack of access to affordable nutritious food is prevalent in low-income communities, we have worked on important ways to fight hunger by teaching individuals nutrition, health and food safety. Skill development and goal setting increased awareness of food resources in local areas and basic cooking/meal planning curriculum were developed and implemented. There were changes in knowledge related to shopping, label reading and eating healthy on a budget. Identified perceived and actual nutrition and health education needs of target populations, identified existing nutrition programs and assessed needs unmet. Identified nutrition and health programming interest areas of Lincoln University Community, evidence-based and best practice nutrition and health promotion programs and material developed, evaluated and implemented. Increased visibility and recognition of LUCEN as a resource for quality nutrition information, outreach education and behavior management assistance, notification for programs distributed to faith-based organizations, agencies, and community partners and utilize new partners for in-kind resources (facilities, printing, advertising, volunteers). Direct Contacts 4,000 Families Adults and Youth.	
8.	**Community, Leadership and Positive Youth Development**	Strengthening skills for small towns, communities, and organizations: The Lincoln University Community Leadership and Development Job Readiness training program was created and put into practice at United Gospel Rescue Mission in Poplar Bluff, Missouri. It continues to give men an opportunity to learn personal and professional soft skills. United Gospel	Education and Communication with Underserved Populations

		Mission is a homeless shelter for men who are underemployed, unemployed and in recovery from drug and/or alcohol addiction. This is the first program of its kind in the area. Most of those participating in the program are in recovery and have been released from prison. The Job Readiness program provides these people with a second chance at life. The program improves their quality of life and allows them to reconnect with families and loved ones. Men living in a small rural town Missouri town in southeast Missouri who are underemployed, unemployed and in recovery from drug and/or alcohol addiction. Women in domestic violence shelters need employment skills. Due to the growth of small towns and community-based organizations, the individuals that manage them and the numerous laws associated with managing these small towns, many of the individuals find themselves confronted with growing pressure to demonstrate their skills in managing the resources of their organizations. There is a need to improve producers' knowledge of resources in local food markets. To enhance the educational development of the youth involved in programming related to gardening. What has been done: • LUCE developed and implemented a program to teach personal and professional soft skills. Women in a domestic violence shelter were prepared with skills for job readiness. The job readiness program has trained more than 200 people and helped 25 percent of those trained to become employed by local businesses in the Popular Bluff area. • The Community Development program works with city leaders on planning and implementing viable policies.	

		Positive Youth Development and 4H: Highlights: The wellbeing of Missouri youth remained a focus during this reporting period. Programming continued to feature the development of healthy decision-making, character and integrity, entrepreneurship, academic and professional ambition in the youth we serve. These aims were reached primarily through after school programs and online youth education. A recent Promise Zone designation in the St. Louis region has initiated the formation of partnerships between the local government and local leadership to address community revitalization challenges, engaging Missouri adults and youth. What has been done: Missouri youth engaged in daily youth development workshops in lab settings with robotic equipment with the goal of teaching leadership skills while at the same time developing interest in stem careers. While the creation of leadership development partnerships is still ongoing, we foresee being able to provide our youth with excellent opportunities to learn how to become productive change agents both collectively and individually on behalf of their communities. Continued implementation of Character Counts and Changing Scenes curricula focusing on character development, life skills and teen pregnancy prevention was conducted in various venues – in the local schools and through after school programming. In addition, youth were exposed to Straight Talk classes from the Division of Youth Services as well as Academic Achievement classes. Jr. MANNRS, an ongoing program in collaboration with various local and national youth-building organizations, continued to bring educational and enriching programming to youth, including a tour of Jackson State University, participation in The National Youth Summit, visits to 4 museums, one of which was Medgar Evers' historic home. Another program focused on education regarding methods and strategies to	

		improve physical fitness with the goal of decreasing youth obesity and increasing academic performance. An LU chapter of Future Farmers of America (FFA) was established to increase diversity among Missouri FFA. Outcomes Students are learning life skills and are preparing to be successful in stem careers through exposure to robotics. Youth are also gaining knowledge of healthy ways of living – particularly how to avoid juvenile delinquency, teen pregnancy and illicit drug abuse. This has been accomplished by helping them become aware of the complex set of factors in their environments that impact their success. They also developed social skills within the school and community context through these after school programs. The results of the programming focused on fitness will be an improvement in health and academic achievement, an increase in physical activity with a corresponding decrease in weight, inches and BMI, and the development of tools that will yield success throughout life. Due to Covid-19 and the necessity of increasing online program delivery, the audience has actually increased, enabling a greater impact.	