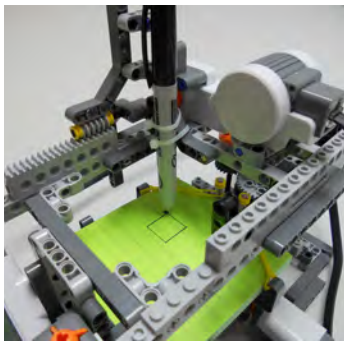
Lincoln University

Cooperative Extension and Research

2014 Annual Report

LINCOLN University
Cooperative Extension and Research



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This is LUCER-MC Report #01-2014 Lincoln University in Missouri and the U.S. Department of Agriculture cooperating. Yvonne Matthews, Interim Dean, College of Agricultural and Natural Sciences. Distributed in furtherance of Food and Agricultural Act, 1977 PL 95-98. Dec. 22, 1981.

Front cover photographs: (clockwise from top left) George Washington Carver Farm; students participating in the Double-dutch program in Charleston, Missouri; pumpkinseed sunfish specimen; white-tailed deer; 3-D printer from the LUCE Robotics Program.

Lincoln University is an equal opportunity provider and employer

College of Agricultural and Natural Sciences

Yvonne Matthews
Interim Dean, College of Agricultural and Natural Sciences

Welcome to the College of Agricultural and Natural Sciences.

This is an exciting time within the College. We have just completed a master plan to convert the 280 acre Alan T. Busby Farm to showcase integrated management systems for aquaculture, grazing management, power generation and water conservation. This will occur through outreach and extension programs, university classes and research. This farm is located eight miles southwest of the university campus off Highway 54. Development of the fully functional system will occur in stages with the first stage of construction – a water reservoir.

Other highlights include: (1) the development of an algae research laboratory to study the use of native species of algae in biodiesel production, (2) a new state-of-the-art adaptive optics and nanophotonics laboratory, and (3) purchase of new equipment for science laboratories.

There are a total of seven majors in the two academic departments within the college. Please feel welcome to contact me or one of the department heads if you have any questions regarding our programs.

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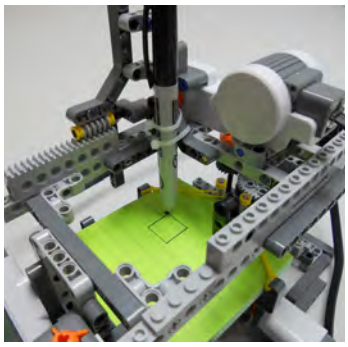


Part One:
Cooperative Extension


BIG CHILI
HIGHLANDER
MISSOURI PRODUCE


Sweet
Corn
$3.00 half doz
No chemical

Economics

Agricultural Economics and Marketing Program

Dr. Emmanuel Ajuzie, State Extension Specialist – Agricultural Economics

The main goal of the Agricultural Economics and Marketing Program (AEMP) is to help small and disadvantaged farmers across Missouri to become and remain economically, socially, and ecologically sustainable. This goal is achieved through the creation of efficient marketing strategies and better direction in good farm activities' management.

1. The Fruit and Vegetable Producers' Marketing Cooperative:

The need to help our clientele discover the best ways to use their very small resources effectively to produce and feed our communities became very important since, a few years ago, the U.S. decided to pursue food security as a national objective.

To attain the objective, the AEMP formed the Missouri Agricultural Products Cooperative (MAPC) headquartered in Sikeston Missouri in 2010. This academic year has seen an increase in the activities of the cooperative.

A member donated a thirty-acre piece of farmland to the cooperative. The farm is used for cooperative production. Individual members produced on their private farms and they market together.

New producers joined the MAPC and more expressed interest for 2015. To enhance the capability of MAPC, the AEMP bought a refrigerated truck for the cooperative with grant funds from Rural Business Enterprise, Rural Development of the United States Department of Agriculture to take members' produce to the market.

The cooperative has seeds left over from 2014 to start spring 2015 planting. New members are joining for the 2015 growing season. There is interest by some farmers in other areas of Missouri to start their own cooperatives. Efforts are underway to coordinate such cooperatives.

2. Farm Activities and Financial Management:

The AEMP assisted some farmers in making arrangements to manage their many farm activities appropriately to make them more profitable.

3. Goat Meat Market Penetration Research:

AEMP is continuing to conduct Extension research in goat meat market penetration, including supply, demand, and willingness to supply and sell.

4. Publication:

The AEMP published one paper with coauthors and submitted another for peer review and publication at a future date.

Animal and Plant Science

Innovative Small Farmers' Outreach Program (ISFOP)

Dr. K. B. Paul, State Extension Specialist – Small Farms

This year, the program was expanded by the eight Innovative Small Farmers' Outreach Program (ISFOP) field staff. Now, the contact base is 456 households. Staff kept in touch with 288 participants. This included 80 minority, 52 women head of households and 18 community-based organizations (CBOs). A total of 336 small and minority farmers attended workshops that were organized by the ISFOP. The staff wrote eight newsletters. They also published a book of 16 farmers' success stories. The printed materials were directly and indirectly sent to over 1,450 persons.

Farmers in the target counties earned more due to ISFOP efforts. Of 288 client families, 180 had an average income increase of $2,464 per farm. This included 31 minority and 13 women sole proprietors. As a result of our direct help, 28 farmers got grants for on-farm research and infrastructure development or crop insurance payments. The funding breakdown follows. Four farmers got Sustainable Agriculture Research and Education (SARE) grants. Ten got Natural Resources Conservation Service Seasonal (NRCS) High Tunnel Initiative cost-share funds or funds for building fences. Six farmers got Slow Food USA project grants; two farmers got Farm Service Agency's Noninsured Crop Disaster Assistance Program funds. The ISFOP and the Kansas City Food Hub Coalition had jointly applied for and received $183,000 in grants; this was for a multi-agency feasibility study. The ISFOP continued assisting the Community Action Agency of St. Louis County; as a result, it obtained a United States Department of Agriculture (USDA) Community Food Project grant of $300,000. This will be spent to expand its farm and tiered Community Supported Agriculture (CSA) program. The total grant funding received by all ISFOP collaborators was $639,130. The ISFOP has made impacts beyond the financial. This office has helped many underserved farmers to see that farming can be a satisfying career.

Integrated Pest Management Program

Dr. Jaime C. Piñero, State Extension Specialist – Integrated Pest Management

During FY 2014, the Lincoln University Cooperative Extension (LUCE) Integrated Pest Management (IPM) Program had two major aims. One was sharing IPM knowledge. The second was measuring the impacts and adoption of IPM methods by small farmers. Numerous mid-and small-scale farmers, conventional and organic, saw the benefits of using trap cropping. Trap cropping means growing plants to lure insect pests away from the more attractive cash crop. It is a simple, effective and affordable way to control insect pests. By using trap cropping, farmers reduced inputs and increased income. For example, Jose Fonseca is a vegetable farmer from St. Peters, Missouri. Trap cropping allowed him to save $400 per acre per year on his vegetables. He has not sprayed his cash crops for four years. These important midterm outcomes resulted from LUCE's Extension efforts.

Many field days, workshops, farm walks (demonstrations on-farm) and other educational events targeted farmers in FY 2014. Training was also provided to Extension educators and agriculture service providers. For example, there was a workshop on the invasive Spotted Wing Drosophila (SWD) in November 2013. Experts trained staff from LUCE, University of Missouri Extension, Natural Resources Conservation Service (NRCS), Missouri Department of Agriculture (MDA) and Missouri Department of Conservation (MDC). Important midterm outcomes were recorded using a web-based 11-month post-workshop survey. It was given to the 42 educators who took the workshop. As a result of this training, 614 farmers were reached by the 24 educators who took the survey. The number of farms visited after the training was 243. Forty-two percent of the educators interacted with minority and/or limited-resource farmers. Ninety-two minority and/or limited-resource farmers were reached. This type of Extension IPM activity has proven successful. The outcomes highlight the efforts that the LUCE IPM program is taking to train Extension educators within and outside Missouri in necessary IPM skills.

Plant Pathology Program

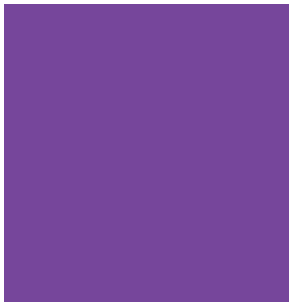
Dr. Zelalem Mersha, State Extension Specialist – Plant Pathology

Lincoln University Cooperative Extension's (LUCE) Plant Pathology (PP) program provides fact-based information about the proper diagnosis, identification and management of vegetable and small fruit diseases. The program focuses on reaching out to minority and underserved growers.

In May 2014, the program hired Martha O'Connor, Plant Pathology Technician. A train-the-trainer workshop was held at George Washington Carver Farm from June 26-27, 2014. Over forty educators and trainers participated. Extension plant pathologists and diagnosticians from the University of Missouri, Purdue University, Kansas State University, University of Arkansas and Agdia, Inc. shared their expertise. The workshop covered on-site symptom-based diagnostics and laboratory-assisted identification techniques of various vegetable and small fruit diseases. Missouri Sustainable Agriculture Research and Education (SARE) funded the workshop.

Research and demonstration plots of various cucurbit (a plant family that includes melons, squash, etc.) diseases were successfully conducted since April 2014. This includes a project funded by the North Central-Integrated Pest Management Center (NC-IPM), "Integrated Management of Watermelon Diseases." Project findings were shared at such events as the Vegetable Field Day in August 2014. Also, various senior and youth groups visited the three raised beds used by the PP program to demonstrate eco-friendly disease management methods. PP presented at two annual field days: Alan T. Busby Farm, Jefferson City, Missouri; and Tomato Field Day, Mt. Vernon, Missouri. Classes were also taught to over 204 Missouri Master Gardeners™.

More than 20 farms visits occurred throughout the state. These visits were conducted in collaboration with the Innovative Small Farmers' Outreach Program (ISFOP), Vegetable IPM Program and University of Missouri Extension. Disease identification was made for 189 plant samples.



Small Ruminant Program

Dr. Charlotte Clifford-Rathert, State Extension Specialist – Small Ruminants

In FY 2014, the Lincoln University Cooperative Extension (LUCE) Small Ruminant Program offered 27 educational opportunities to producers. They took place in 15 Missouri counties. Eleven herd disease and seven fecal egg count/FAMACHA© (related to intestinal parasite assessment) trainings occurred. Seven events dealt with brush control. There were four related to youth activities: AgDiscovery, Sprouts and Roots (SR) and one section of the Young Medics program. SR hosted a special visit from 25 of the "exceptional 4-H/FFA (Future Farmers of America) youth" from Louisiana. Youth activities included cheesemaking and 4-H and FFA youth goat or sheep projects to prepare for fairs. Seven farm consultations related to management decisions.

Dr. Charlotte Clifford-Rathert, State Extension Specialist - Small Ruminants, represented LUCE at one national meeting: Langston Goat Day, in Langston, Oklahoma. She also spoke at the Missouri Livestock Symposium and took part in two webinars. A University of Missouri student intern worked with the capacity building project.

Value-added products (e.g., goat sticks) continued to be well-received by the general public; at producer events, they were a good example of a marketable product. The first Browsing Academy was held at the Alan T. Busby Farm in October 2013. The second Browsing Academy was held in Southwest Missouri at Crowder College in September 2014. Topics at both conferences included drought management, soil fertility, herd health, nutrition and more. Goat meat was served at all field days. The Capacity Building Grant using goats to control invasive brush finished its third year. Demonstration sites at Busby Farm and Crowder College showed less invasive vegetation and more native grasses. A joint project with the United States Department of Agriculture (USDA) – Natural Resources Conservation Service (NRCS) Elsberry Plant Materials Center (Elsberry, Missouri) completed its fourth year; it demonstrates how goats can eliminate honeysuckle and buckthorn.

About 12,000 indirect contacts were made via phone, email and media; 2,103 direct contacts were made through program events, webinars, field days and eXtension.org.

Southwest Missouri Small Ruminant Program

Dr. Jodie Pennington, Regional Small Ruminant Educator

Throughout the Southwest region, meetings about producing and marketing small ruminants were conducted. The audience was producers and the industry. A trifold display promoted small ruminant educational programs at 17 events; these included field days and goat and sheep sales. At Crowder College, using goats to control browse and undergrowth was displayed. Using hair sheep on small acreage was shown on a Hmong farm and at a field day. A Hispanic producer shared how to use winter annuals to add feed during a shortage. There was also an active small ruminant Advisory Committee in 2013.

Great effort was made to share programs with minority producers, especially Asian-Americans and Hispanics. Good working relationships were maintained with many local businesses and government agencies. Email lists for regional goat and sheep producers were enhanced. They were used to promote educational activities.

Short-term impacts of the program included a more informed public. The office made 6,011 direct contacts. There were an estimated 104,440 indirect contacts; these were made through articles or press releases in local, regional, state and national media. Interviews were given for eight articles in magazines or radio scripts.

Routinely, industry contacted the office for information. Of 279 persons, follow-up surveys showed that 90 percent made management changes based on the help our office gave. As a result of these meetings, 99 percent of producers learned something new; 94 percent planned to change a management practice as a result. Ninety percent who attended the previous year's meetings had made management changes; this was a midterm indication of impact. Many more producers and industry personnel now know of the Small Ruminant Program. This should promote long-term sustainability.

Environmental Science

Composting Program

Dr. Hwei-Yiing Johnson, State Extension Specialist – Composting

Photo 1: Oyster mushroom growing on a medium made of compost using Japanese beetles and mixed paper shreds.

Photo 2: Three kinds of worms: ***Eisenia fetida*** *(top),* ***Eisenia hortensis*** *(middle) and* ***Amynthas agrestis*** *(bottom).*

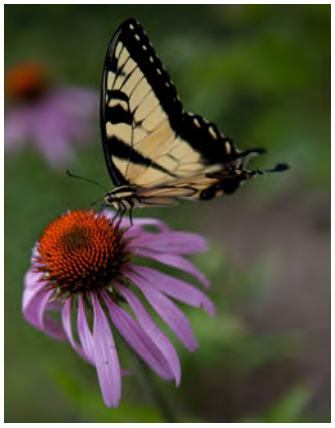
In FY2014, the Lincoln University Cooperative Extension (LUCE) Composting program provided educational and community outreach services. Composting facility tours were give to students and visitors at field days and on request. Dr. Hwei-Yiing Johnson, State Extension Specialist, gave composting training and demonstrations on and off campus. Some events assisted other Extension programs. Also, community groups were served, such as Master Gardener™ and Master Naturalist™ groups.

LUCE strongly supports composting on farms. Johnson responded to calls from farmers and ranchers and made farm visits. She consulted to help meet farmers' specific needs. LUCE demonstrated effective composting of organic waste: yard waste, garden debris, food waste and animal manure. Also, Japanese beetles caught in insect traps can be composted. Dual composting methods were shared; aerobic (with oxygen) followed by vermicomposting (using worms to compost) can shorten the process. It can also yield high quality vermicastings (worm manure). LUCE also showed how to use compost to grow edible mushrooms (Photo 1).

LUCE added specimens to its worm collection. This strengthened vermicomposting education. LUCE taught that Eisenia fetida is a better composting worm than Eisenia hortensis, a larger worm good for fishing bait. The public was warned about the invasive worm, Amynthas agrestis (Photo 2).

To compost food waste, LUCE encouraged using EM® (effective microorganisms) Bokashi (Japanese for "fermented organic matter"). At a local middle school, students experienced EM® Bokashi. In summer school, they practiced composting lunch waste.

Compost tea brewing was also promoted. It yields a solution rich in beneficial microbes (living things that need a microscope to be seen). LUCE consistently brewed good quality compost tea using worm castings. Compost tea supports plant growth and controls pathogens (agents that cause disease); it also protects plant and soil health.



Native Plants Program

Dr. Nadia Navarrete-Tindall, State Extension Specialist – Native Plants

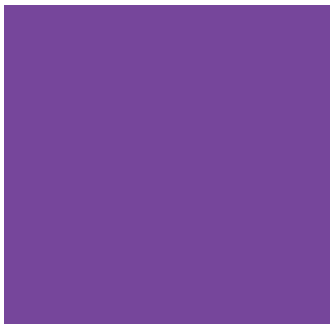
By growing native plants, people are making a positive impact on the environment; they are also increasing biodiversity. In FY 2014, the Native Plants Program (NPP) offered workshops, seminars and field days related to native plants, health and nutrition. Approximately 3000 direct and 2000 indirect contacts were made.

This year, the NPP began to work with the Center of Rural Affairs in Nebraska; two agriculture field days for veterans were organized jointly.

One new event was Dining Wild. It took place on the Lincoln University campus. The event included garden tours, a social mixer, dinner and educational presentations. Food and beverages were prepared or flavored with native edible plants. Missouri organic meats, local produce and crayfish were on the menu. Close to 70 percent of the 150 participants filled out evaluations. When asked if this event was worth their time, the average response was 9.8 out of 10.

The 7th annual In Touch with Nature field day took place at Alan T. Busby Farm. Walking tours and wagon tours were offered. There were exhibits and workshops on a diversity of topics related to nature and agriculture. More than 300 attended this event.

The Gardening as Therapy for Physical and Mental Health and the FINCA project (Families Integrating Nature, Food and Agriculture) are both funded by National Institute of Food and Agriculture (NIFA). This funding made possible the creation of an Ag Hub in the south part of the LU campus. Each year, this hub brings over 5,000 people to campus. In FY 2014, the NPP collaborated with Lincoln University Cooperative Extension (LUCE) satellite offices in Kansas City, St. Louis and the Bootheel; training on gardening, health, native plants and nutrition was offered to seniors.



Natural Resource Program Development, Recruitment and Retention

Dr. Adrian Andrei, Principal Investigator – Wildlife Science

This grant-funded project builds teaching capacity in the College of Agricultural and Natural Sciences. One objective is to recruit and retain students. Another goal is to promote their professional growth in the natural resources emphasis area. In 2014, a field training course was offered to students. In May, LU faculty took six students on a trip to New Mexico and Arizona. The focus of the trip was to train students to identify birds in the field. Students and faculty visited national forests and national parks and monuments. They observed 168 species of birds. Students developed the ability to identify birds by sight and sound. This field training will continue into the summer of 2015. An educational trip to Texas is planned.

Between May and August, two undergraduate students were hired and given further instruction as part of a research project. The students performed field surveys of nesting birds in Missouri forests and fields. They tested the hypothesis that bird diversity and abundance would be lower in and near cities and towns compared to the surrounding farmland. The students will present their findings at the Missouri Natural Resources Conference, Osage Beach, Missouri, in February 2015. In the fall of 2014, two student volunteers from the Lincoln University Wildlife Club assisted the Missouri Army National Guard; they helped to organize an archery deer-hunting event for disabled and injured veterans. These are some examples of Lincoln University's focus on helping students develop marketable skills in the field of natural resources management.

Youth, Family and Community Development

Young Medics Program

Adrian Hendricks II, Regional Educator – Youth Development

The Central Missouri office of Lincoln University Cooperative Extension (LUCE) hosted the Young Medics program during fiscal year 2014. This youth program raises the awareness, knowledge and skill level of Central Missouri youth in anatomy, nutrition, science and wellness. There were thirty-two Young Medics students, ages 9 through 17. Ninety percent of the 2014 participants were minorities, and 60 percent were female. The program worked with the Called to Academic & Leadership Excellence and Building Character and Confidence (CALEB) Science Club and the University of Missouri's School of Medicine. In this way, youth received hands-on learning through inquiry and research. The Young Medics camp is a 16-hour small classroom learning experience.

Surveyed students reported the following:

- All reported at least a 75 percent increase in knowledge as a result of attending the Young Medics program.
- Ninety percent of participants improved their medical science awareness and knowledge.
- Students noticed a 70 percent increase in their knowledge of plant physiology content.
- Students saw a 75 percent retention rate of anatomy content related to the human brain.
- Students reported a 60 percent retention rate of first aid content related to emergency response and crisis management.

The Young Medics program partnered with the University Hospital, Columbia, Missouri; University of Missouri Veterinary School; University of Missouri School of Medicine; CALEB Science Club; Missouri Department of Health & Senior Services; LUCE Small Ruminant Program; and the biology faculty at Lincoln University.

17th Missouri Institute on Minority Aging (MIMA)

Deborah Jenkins, Research Assistant I – Paula J. Carter Center on Minority Health and Aging

Lincoln University Cooperative Extension's (LUCE) Paula J. Carter Center on Minority Health and Aging (PJCCMHA) supports the older population in reaching optimal health. The hallmark of the PJCCMHA's outreach efforts is the Missouri Institute on Minority Aging (MIMA). MIMA is a forum that presents evidence-based data to aging consumers, state and local agencies, and academic professionals in the fields of aging and health.

One hundred and five senior citizens from throughout Missouri attended the 17th Missouri Institute on Minority Aging. The event, themed "Aging Artistically," occurred from Tuesday, August 26 through Thursday, August 28, 2014, in Columbia, Missouri. Twenty concurrent and five general sessions focused on teaching older adults strategies to improve and maintain health and wellness while also promoting creativity.

Based on a post-conference survey, 98 percent of attendees learned valuable information about senior health issues; they plan to apply their learning in their daily lives. One participant was pleased that MIMA "enlightens you about medical issues [with information] that you don't get elsewhere." Another said, "Being a minority with diabetes and high blood pressure, I will be using everything: diet, exercise, tips on meds and computer info."

MIMA includes a coronation ceremony of a statewide King and Queen. They are chosen from regional representatives who serve as advocates for the PJCCMHA. David and Hameeda Abdullah from Kansas City, Missouri, were crowned MIMA King and Queen for 2014-15. They and the former King and Queen engaged in intergenerational work with LU's Royal Court during Homecoming.

MIMA attendees who participate in more than one MIMA conference become Lay Leaders. They represent and promote PJCCMHA programs in their communities. As a result of Lay Leaders' efforts, PJCCMHA will begin the initiative "We're Looking for a Few 'More' Good Men (Ask Us Why)." This community outreach campaign promotes men's health and wellness.

Cooperative Extension Satellite Offices

Kansas City Urban Impact Center

Marion Halim, Regional Coordinator – Kansas City Urban Impact Center

The Lincoln University Cooperative Extension (LUCE) Kansas City Urban Impact Center's (KCUIC) Mentoring and Anti-bullying program impacted 150 youths. The goal of the programs is to encourage youth to remain optimistic. To do so, youth shadow and mirror adults and other suitable role models. They learned life skills such as decision making. Their grades improved and class attendance increased. The program also reported positive changes in five youth; they faced fewer conflicts and suspensions. This was proven because they also had no in-school suspension or parent-teacher conference in the six-week period.

The double Dutch program attracted 25 teams comprised of youth from various schools in the greater Kansas City metropolitan area. During training and competition, each student burned up to 800 calories. One youth lost eight pounds during this program.

Agricultural and Expanded Food and Nutrition Education Program (EFNEP) initiatives were aimed at increasing food accessibility. This was done by focusing on food security for at-risk groups. For good health, participants were taught they must have a way to obtain nutritious food. But there is often a lack of access to low-priced, nutritious food in low-income communities. Therefore, it is vital to create ways to fight hunger. One way is to teach people to grow and sell their own food. Teaching individuals and communities to grow wholesome food makes it more accessible and less costly. And, it adds to economic growth. The number of chronic diseases is also reduced.

This program served about 100 people by direct contact in 2014. The EFNEP program helped limited-income families and children improve their eating habits. It also supported them in developing active lifestyles. A major program goal was to increase the participants' ability to select and buy nutritious food while on a budget. Another goal was to practice safe food handling and storage. Those who took part in the program learned to read the Nutrition Facts Label.

Another program sought to have underserved seniors see key links between nutrition and mental and physical well-being. KCUIC offered seniors physical activity and training in how to make beneficial lifestyle changes. They became healthier and more productive. These educational programs increased the quality of life for seniors on restricted incomes. Each year, this program works with 72 seniors.

The KCUIC's Academic Achievement program taught life skills. It also improved the academic achievement of 150 underserved youth. Youth learned by doing, with the help of a caring adult. This program aims for a 50 percent decrease in school suspensions. A second goal is that students improve at least one grade level in reading and math each semester.

Bridging the Intergenerational Gap (B.I.G.) is an international program that pairs youth with their elders. This raises awareness between the generations. The B.I.G. program teaches youth how to have a positive outlook. Likewise, youth's interaction with seniors helps the community develop wise, educated and optimistic future leaders.

St. Louis Urban Impact Center

Patrice Dollar, Regional Coordinator – St. Louis Urban Impact Center

The St. Louis Urban Impact Center reached over 2100 residents during fiscal year 2014. This was achieved by attending resource fairs, providing classes, performing one-on-one consultations, attending meetings, etc.

The St. Louis Horticulture program addresses community food deserts; it helps clients transform vacant land into productive green spaces. Twelve farmers increased their total income by $7,000. Six farmers received grant funding, with two getting Slow Foods grants of $3,000. One farmer received Sustainable Agriculture Research and Education (SARE) Farmer Rancher grants of $5,000. Grants for two farmers came to $15,500. The sweet potato project got a private grant of $20,000. One school garden was awarded $5,000.

The Volunteer Income Tax Assistance Program (VITA) gave free tax assistance to 261 taxpayers. Taxpayers received $172,153 in earned income tax credits. State and federal refunds equaled $362,259.

The Men on Business program served about 150 students in five school districts: St. Louis, Ferguson-Florissant, Jennings, East St. Louis and Alton, Illinois. This program exposes students to Jr. Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS).

The six-week Summer Enrichment Program served over 40 youth. They were engaged in an array of activities, including field trips to the Missouri Botanical Garden and the St. Louis Zoo and Art Museum. They also took swimming and golf lessons.

The Cyber Café is an optional computer literacy/technology service where clients meet one-on-one with Lincoln University Cooperative Extension (LUCE) staff for professional, personal and educational assistance.

Dare to be Queen is an intergenerational and educational women's conference that served over 90 participants this year. There was a high degree of participant satisfaction with the health, financial and technology segments.

A Message of Hope in Community Healing and Empowerment was held in August 2014, in response to the unrest in Ferguson, Missouri. Forty-six people attended. A panel discussion of students and community leaders focused on what it takes to heal and empower the community.

Southeast Missouri 1890 Extension Programs

Brenda Robinson Echols, Regional Coordinator – Southeast Missouri



Lincoln University Cooperative Extension (LUCE) Southeast programs focused on four pillars: academic achievement; abstinence education; childhood obesity; and Science, Technology, Engineering/Entrepreneurship, Agriculture and Math (STEEAM).

Academic Achievement

Afterschool tutoring programs were offered in Caruthersville and Sikeston, Missouri, for students in grades K-8. Students received help with homework and individual tutoring in math, reading and spelling. They were also exposed to web-based learning sites. An average of 35 students at each site attended daily. Over 80 percent of students in the Sikeston program made the honor roll, as did 50 percent in Caruthersville. Eight fourth-grade students were having problems grasping the new math; this improved after a few weeks of tutoring. Their teachers reported that they did not know what was being done at Lincoln's afterschool program, but it was making a huge difference. College prep information and Free Application for Federal Student Aid (FAFSA) applications were completed for over 25 students.

Abstinence Education

The Teen Outreach Program (TOP) targeted fifty students in grades 6-8 in Charleston, Sikeston and Caruthersville, Missouri. TOP teaches abstinence education along with having students take part in service learning projects. The students helped with the reenactment of the Sharecroppers Strike that took place in the Bootheel in the 1930s. This taught them a valuable history lesson. Teen Talk was another program that was taught to the Missouri Division of Youth Services; health classes stressed abstinence.

Childhood Obesity

Summer enrichment programs served over 200 K-8 students daily in June and July. Students were engaged in physical fitness, dance, stepping (percussive dance), drama, life skills and a reading partnership with the local library. Each site tended a community garden. The summer enrichment program saved families $640 per child (the cost of a similar YMCA program); the total savings was $128,000.

Fitness and nutrition classes were also held for adults. A total of 25 inches were lost. The group shed 97 pounds jointly.

STEEAM (Science, Technology, Engineering, Entrepreneurship, Agriculture and Math)

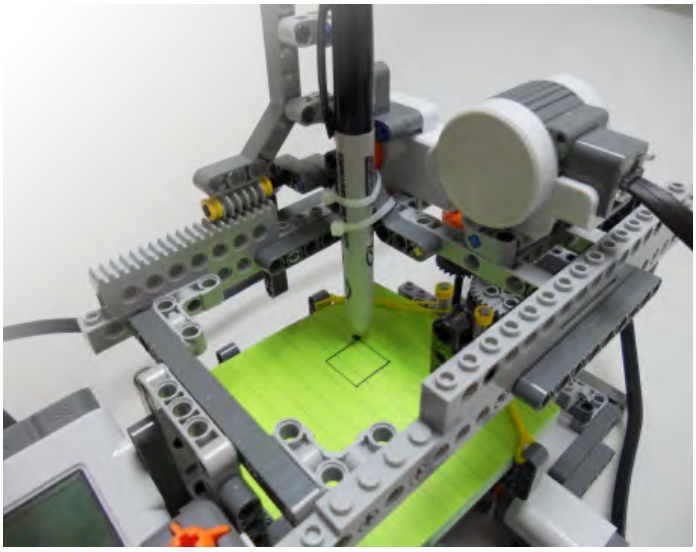
By partnering with the Bootheel Youth Museum, LUCE was able to teach and expose over 1000 students to STEEAM areas. This was done using experiential learning workshops. A Youth Agricultural Conference targeted 50 students in grades 6-11. It taught students about opportunities and careers in agriculture. As a result, several students chose STEEAM areas as their field of study.

Kids Beat Youth Development Program

A grant through the Missouri Department of Mental Health provided a variety of programs such as substance abuse prevention, and others taught black history. The program also included an Angel Tree Project, Real Fathers/Reel Men and Kids of Distinction/Kiddie's Kidz Garden.

Intergenerational Program

Women of Wisdom and Seniors Moving On are comprised of senior citizens. These groups allow elders to share information, history, skills and ideas with youth. Seniors taught classes on local history, sewing, gardening, and canning and preserving fresh fruit and vegetables.



Part Two:

Special Projects

Abstinence Education

J. Michael Washington, Abstinence Education Grant/Intergenerational Programs Coordinator

The Missouri Department of Health & Senior Services contracted with Lincoln University Cooperative Extension (LUCE) for a fourth year to provide the Pause for the Cause Abstinence Education Program (AEP). The project focused upon African-American youth (ages 10-17) and their parents/guardians. The goal was to support the youth's decision to abstain from sexual activity. In Missouri, a much larger number of African-American youth reside in St. Louis, St. Louis County, Kansas City, Jackson County and Southeast Missouri (Mississippi, New Madrid, Pemiscot and Scott counties). LUCE worked with satellite Extension offices in those areas. The aim was to educate the community by working mainly with faith-based groups.

In FY 2014, 640 students in six counties across Missouri were served by the community-based AEP Choosing the Best. It is both age and culturally appropriate. Surveys were given to each student at the program's start and end. The program evaluation indicated the following:

- The curriculum increased knowledge and awareness about sexually transmitted diseases (STDs) and sexual risk.
- Students endorsed abstinence as a way to have healthy relationships and to avoid pregnancy and STDs.
- Students were less likely to see sexual intercourse as a normal part of adolescent development.
- Students were willing to endorse abstinence as a personal choice; however, they did not feel confident in their ability to resist the advances of a partner who wanted them to have sex.
- Students' confidence about talking to a parent or guardian about sex, alcohol or drug use did not change significantly.
- About two-thirds of students reported being more likely to abstain from sexual intercourse until marriage.

Throughout FY 2014, the curriculum was delivered via classes, state-approved STD/HIV presentations and community service events in each county. Graduation ceremonies were held in St. Louis, Kansas City and Sikeston, Missouri, for students who completed the program.

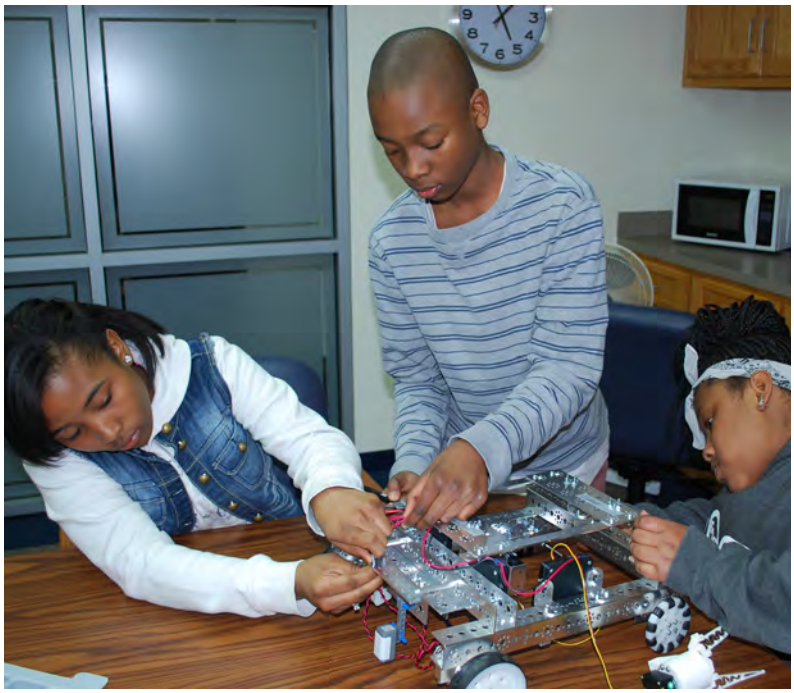
AgDiscovery

David Kiesling, Special Projects Coordinator

AgDiscovery is a two-week summer outreach program. It is sponsored by the United States Department of Agriculture (USDA) - Animal Health Plant Inspection Program (AHPIS). Lincoln University is one of seventeen universities involved in this program. The program targets a diverse population of students aged 14-17. These students, from all areas of the US, have displayed an interest in animal science and urban gardening. This is the third year that LU has hosted the AgDiscovery Program. It provides hands-on experience through labs, workshops and site visits. In 2014, 10 students attended the program from Sunday, July 13 through Saturday, July 26, 2014. They came from Arkansas, Illinois, Iowa, Kansas, Missouri, New Jersey, New York and Texas. Students learned about LU and about organic farming, plant pathology and urban gardening. Health and management of animals and value-added economics were also covered.

The program's goals include the following:

- an increased understanding of the career opportunities in animal and plant science
- the exposure of more ethnically/culturally underrepresented students to careers in agriculture
- a new realization and appreciation of the importance of animal and plant science on a national and global scale
- a greater number of students entering the animal science and plant science programs at Lincoln University
- enhanced diversity of the students entering animal and plant science
- an increased acceptance of other people's diversity and individuality



Robotics Program

Gregory Pierson, Research Engineer – Robotics Program Coordinator

The Lincoln University Cooperative Extension (LUCE) Robotics Program has equipped regional educators with curriculum and technology resources. These tools help teachers and youth to further develop science, technology, engineering and mathematics (STEM) skills and interests. This program impacted about 80 students aged 8 to 18. The program occurs at five LUCE sites. These are in Caruthersville, Jefferson City, Kansas City, Sikeston and St. Louis.

Now, each LUCE site is better equipped. A dedicated robotics laptop is preloaded with all the needed software. All sites have an extra NXT MINDSTORMS® kit (robotics from Lego®). Two educational resource kits have unique components; these enable students to enhance their robotic designs. New curriculum (279 pages) has been written. Students will now find example code (C-based programming language), safety lessons and building instructions. They can also consult relevant math examples and exercises and outside references that extend learning. In addition, 386 pages of open-source curriculum have been combined. These include lessons on safety, example code (C-based programming language) and theory of operation. There are also practical exercises, instructor lesson plan development tools, building instructions and quizzes.

In 2014, students will start using a newly acquired 3-D printer to prototype mechanisms. These will be created as part of a design team made up of students.

Part Three:

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Innovative Small Farmers' Outreach Program (ISFOP)

Dr. Kamalendu Paul, Director
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Part Four:

Cooperative Research Programs

Animal and Plant Science

Design of a Nanosensor for Detection of Luteinizing Hormone in Small Ruminants

Dr. Zahra Afrasiabi, Principal Investigator

The genetic quality of animals is a key factor in the economics of production success. Males represent 50 percent of the genetics of a flock or herd; therefore, use of high-quality males is the most common method of increasing the genetic quality of the herd or flock. But, buying high-quality males is often cost-prohibitive for small farms, so their ability to compete with larger farms is limited. One alternative to owning a costly male is to use artificial insemination (AI). One major problem associated with AI, especially in sheep, is deciding on the best time for it. If a device could be developed to find the proper time to breed in the absence of a male, this would be very helpful. It could result in a greater use of AI by small farms.

The change in luteinizing hormone (LH) is one of the most common fluctuations that can be measured in the blood prior to estrus (time when a female animal is fertile) and ovulation (when the egg moves from the ovary). The goal of this research is to develop a device that can quantify real-time changes in LH concentrations. The device must also be easy to use on the farm without needing special instruments. The final product will be a colorimetric paper-based sensor; a simple color change to red will show that the animal is ovulating and ready for AI.

To achieve the objectives of the project, a new peptide (linked amino acid) sequence for recognizing LH was identified and synthesized. The sensor was created. And real-time in-field testing was performed on sheep serum (part of blood plasma). The developed sensor can detect a luteinizing hormone surge. However, this research continues in order to develop a lateral flow system and improve the specificity and detection limit of the device.

Integrated Pest Management Program

Dr. Jaime C. Piñero, State Extension Specialist – Integrated Pest Management

At the Alan T. Busby Farm, an Evans-Allen project focused on increasing the sustainability of farming systems through holistic management practices. These practices seek to minimize inputs from sources beyond the farm. One study aimed to develop and assess mass trapping to help small and mid-scale farmers manage Japanese beetles organically. In 2014, nearly two million Japanese beetles were captured with only 48 traps; these were combined captures from three farms. Over three years, 48 traps captured nearly 5 million insects. Another study showed that Japanese beetles can be easily and successfully composted; they were added to high carbon/woody farm waste. Beetle-based compost is a good quality soil amendment (addition). Also, composting reduces or removes the odor of decomposing beetles. This compost works well to grow mushrooms. It can also be used as a fertilizer in organic high tunnels and for field crops.

Ceres Trust, a Midwest-based private foundation that promotes organic agriculture, funded a series of studies. Research conducted over several years at multiple farms has shown the benefits of trap cropping. It is a good way to manage several insect pests of cucurbit (vegetable family including melons and squash) crops. Trap cropping means growing plants to lure pests away from the more attractive cash crop. Results show that Red Kuri and Blue Hubbard squash work well as trap crops for spotted and striped cucumber beetles and squash bugs. Seven farmer cooperators adopted trap cropping on their vegetable farms. Four of these farms are certified organic. Other organic projects integrated small ruminants (goats and sheep) with weed and insect pest control.

For FY 2014, $530,089 in grants were awarded by federal and private groups. Four book chapters and two peer-reviewed research articles were published. One article was printed in a trade magazine. Numerous poster and oral presentations were given at local, regional and national conferences. Four presentations were given in China.

Estimating the Daily Intake of Essential and Nonessential Elements from Lamb m. Longissimus Thoracis et Lumborum Consumed by the Population in Missouri

Dr. Abua Ikem, Associate Professor

This research estimated the daily intake of essential and nonessential elements from the lamb muscle longissimus thoracis et lumborum (m. LTL) available to people living in Missouri. Three types of lamb m. LTL were purchased: Missouri grain-finished (n = 36), Missouri grass-finished (n = 40) and imported New Zealand grass-finished (n = 40). All were assayed (evaluated) to find their element composition. The total mercury in the samples was found by atomic absorption spectrometry (used to find the concentration of an element in a sample). Other elements were analyzed by inductively coupled plasma-optical emission spectrometry (detecting trace minerals based on the radiation they emit). Analysis of certified reference materials (DORM-2 and TORT-2) gave recovery rates ranging from 86% to 108% and 85% to 104%, respectively. The quantity of essential elements in Missouri grain-finished and Missouri grass-finished lamb m. LTL followed the order: potassium > phosphorus > sodium > magnesium > calcium > zinc > iron. The order in the imported New Zealand grass-finished group is as follows: potassium > phosphorus > sodium > calcium > magnesium > zinc > iron. Because many variables lacked normality (they did not fit within a normal distribution), a nonparametric Kruskal–Wallis comparison test was performed. The results suggested no significant difference ($P > 0.05$) in the element composition among the lamb m. LTL groups. The estimated daily intake of 14 elements from the consumption of 100 g lamb m. LTL posed no hazard to consumers.

Divergent Selection for Parasite Resistance in a Closed Line of Kiko × Boer Goats

Dr. Bruce Shanks, Principal Investigator

As an alternative to traditional livestock, goats are becoming more popular. This results from their ability to profitably convert low-value feed into meat, milk and fiber products. They are also good at controlling weeds and brush. Parasites (organisms that live off a host organism) are the most serious economic problem faced by U.S. goat producers. Parasites are mostly controlled by commercial dewormers; however, there are increasing concerns that parasites are becoming resistant to treatment. Thus, this research seeks to use the host animal's natural immunity to increase the level of parasite resistance.

In 2011, divergent (dissimilar) breeding groups of Kiko × Boer goats were set up at Lincoln University's George Washington Carver Farm. Goats were selected for resistance to parasites (high line) or for susceptibility (low line). Boer does were mated for four seasons to corresponding high- or low-line Kiko bucks. The resulting Kiko x Boer offspring are being mated to corresponding high-line or low-line Kiko bucks. The offspring will be 3/4 Kiko x 1/4 Boer. After this, the lines will be closed. Then, the most parasite-resistant animals from the high line and the least parasite-resistant animals from the low line will be mated within line. This will continue for several more generations. Typical production traits and parasite resistance measures have been recorded from weaning until just before selection decisions were made.

Four abstracts have been presented. One presentation was made at the 2014 American Dairy Science Association (ASAS) and American Society of Animal Science (ADSA) Joint Annual Meeting (2014 ASAS Midwestern Section) and one at the 2013 Agriculture and Rural Development (ARD) Meeting. In 2013 at the ARD, LU received second place in the graduate competition of the Animal Production Section.

Genetically selecting goats for improved parasite resistance might give producers a new option to reduce parasitism. This project is part of a long-term selection project and is ongoing.

Establishing a Footrot-resistant Katahdin Sheep by Genetic Marker-assisted Selection

Dr. Tumen Wuliji, Principal Investigator

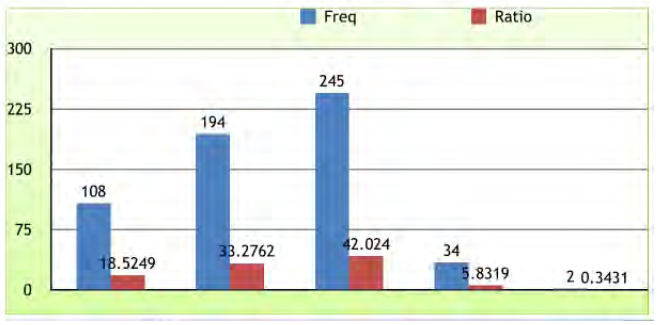
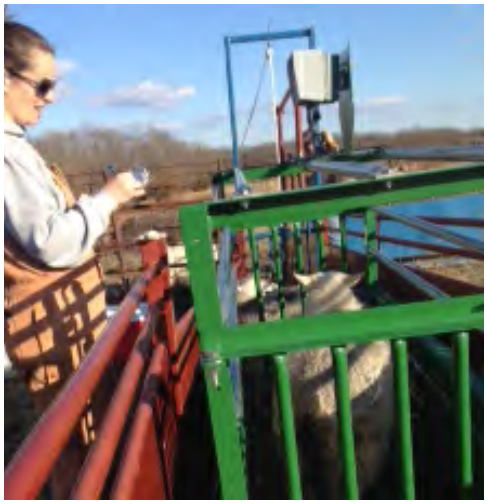


Figure 1. Number of sheep (n = 583) and ratios in five footrot score groups.

Food animal diseases affect production economics, animal welfare and human food safety. Footrot is a very contagious disease that mainly infects goats, sheep, cattle and some wild ungulates (mammals with hooves). However, the genes of some sheep allow them to tolerate footrot infection. Therefore, this study focuses on genetic screening, identification and selection of a footrot-resistant genotype (genetic makeup) within hair sheep breeds or flocks. The goal is to create a line of sheep that can resist footrot.

At George Washington Carver Farm, there were Katahdin ewes (n=120), and 30 rams (Katahdin, K = 16; Dorper, D = 7; and Texel, T = 7). Ewes were divided into two groups. One was a footrot-resistant selection flock (SF = 60). The second group was a crossbreed genotype flock (CF = 60). The SF animals were bred once a year within breed (K) mating group as a footrot-resistant selection flock. The CF ewes (K) were crossbred with Dorper and Texel rams (1st and 2nd years); their F1 (first generation) progeny was backcrossed to one of the two sire breeds (3rd and 4th years), respectively. Selective breeding generated crossbreed F1 progeny groups of ½K½D and ½K½T. The crossbreed F1 ewes will be backcrossed to Texel (n = 4) and Dorper (n = 4) sires in the third and fourth years of the project to generate F2 (second generation) three-breed crosses of ¼K¼D½T and ¼K¼T½D. After four breeding seasons, there will be one selected breed (Katahdin) and four crossbreed genotypes (½K½D; ½K½T; ¼K¼D½T and ¼K¼T½D) available for footrot-resistant challenge, genotype marker typing, selective breeding and genetic linkage analysis.

From 2011 through 2013, the project carried out its breeding plan and gene marker screening tests. Results show that a large ratio of the SF possesses genetic resistance to footrot disease (Figure 1). Also, 38 farmers' flocks in Missouri and six flocks in other states were inspected for footrot. An on-farm biosecurity protocol was developed for use during footrot outbreak seasons.



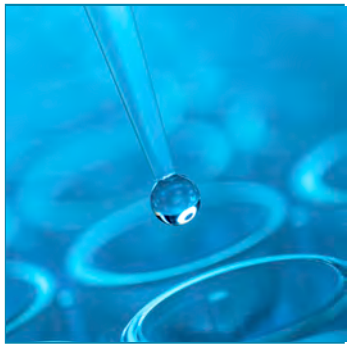
Performance of Katahdins Grazing Stockpiled Toxic Tall Fescue, Nontoxic Tall Fescue or Persist Orchardgrass

Dr. Bruce Shanks and Dr. James Caldwell, Principal Investigators

Small ruminant producers can use stockpiled forages during the winter. This might save money over buying costly feedstuffs. However, there has been little research that compares grazing stockpiled forages on the performance and reproductive rates of Katahdin ewes. Studies are needed on the effects of stockpiling endophyte-infected tall fescue, endophyte-infected tall fescue or Persist orchardgrass. (An endophyte is a fungus or bacteria that lives in a plant without causing harm.)

A total of 48 spring-born Katahdin ewes were grazed on one of three feeds. The first was endophyte-infected tall fescue. The second was novel endophyte-infected tall fescue. The third was Persist orchardgrass. Excess forage was grazed in early August. In September, 150 pounds of ammonium nitrate fertilizer was applied. The grazing of stockpiled pastures began in November. It lasted for 77 days. At the beginning of the breeding season (December 16), one Katahdin ram was introduced; he stayed in each group for 39 days. There was no difference in ewe weights, body condition scores or average daily gains based on the feed that was eaten. Pregnancy rates also did not differ. The percentage of multiple births was greater for ewes eating novel endophyte-infected tall fescue or Persist orchardgrass compared to endophyte-infected tall fescue. Also, multiple births tended to be greater from novel endophyte-infected tall fescue than from Persist orchardgrass. These findings suggest that grazing stockpiled endophyte-infected tall fescue, novel endophyte-infected tall fescue or Persist orchardgrass during the winter months might result in similar ewe performance and pregnancy rates. However, grazing stockpiled novel endophyte-infected tall fescue might improve the number of multiple births.

One abstract was accepted for the 2015 American Society of Animal Science (ASAS) Midwestern Section. The authors are T. N. Drane, J. D. Caldwell, A. L. Bax, B. C. Shanks, L. S. Wilbers, A. J. Kempker, J. D. Walker, C. A. Clifford-Rathert and A. K. Busalacki.



Environmental Science

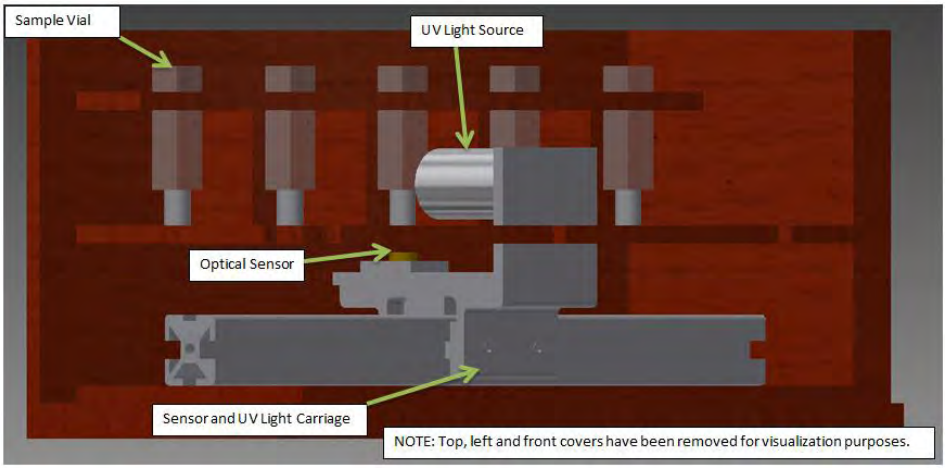


Figure 1.

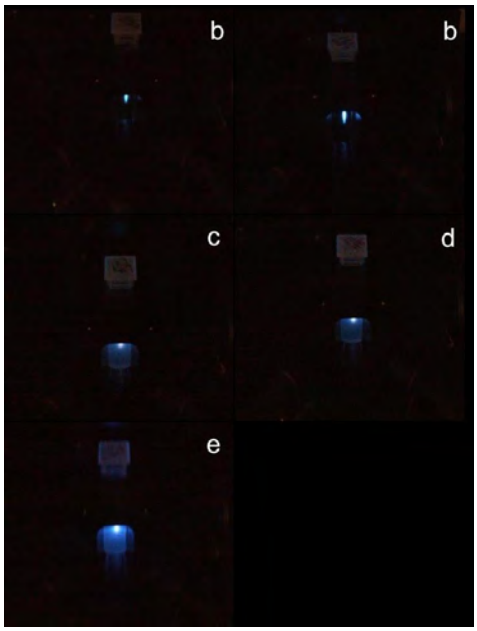


Figure 2.

Biosensor for the Rapid Detection of *E. coli*

Dr. Majed Dweik, Principal Investigator

Human infections from enterohaemorrhagic (causing hemorrhages in the intestine) *Escherichia* (*E. coli*) are commonly linked to eating contaminated food. Different strains of *E. coli* (e.g., O26, O103, O111, O118, O121, O145 and O157) cause most of the infections worldwide. Foodborne pathogens (substances that cause disease) bring about millions of infections each year. They are responsible for many fatalities globally. Along with the threat to human health and safety, these outbreaks also have a major economic impact. The cost related to foodborne illness in the U.S. yearly is about $77 billion.

Microbiological methods are often used in the laboratory to detect pathogenic *E. coli*. These include the enzyme-linked immunosorbent assay (ELISA) and polymerase chain reaction (PCR). These techniques take a long time (24-72 hours) to detect *E. coli*. And expensive equipment is required. The goal of this project was to make an inexpensive, portable, field-deployable device to test for pathogens. It would also be capable of testing multiple samples. To this effect, a platform was built (Figure 1). This device is an optical sensor that can detect fluorescence (visible or invisible irradiation). When the *E. coli* bacterium comes into contact with MUG (a chemical), it results in fluorescent species (Figure 2). This device detects the exact ultraviolet (UV; light with a shorter wavelength than visible light) intensity being emitted due to the fluorescence of the *E. coli*-MUG assay (method of finding out the makeup of a sample). This is displayed as voltage. The sensor is designed to hold multiple cuvettes (used for holding samples). The UV source is mounted on a rail; it moves along to align exactly with the sample being tested. On the same rail assembly, there will be a sensor mounted to detect the fluorescence. This sensor is compact, lightweight and field-deployable. It also has the ability to test multiple samples in a short time (8-18 hours).

Enhancing Biodegradation of Herbicides Using Biofilter Systems

Dr. Frieda Eivazi, Principal Investigator

The deliberate use of pesticides in agriculture and accidental spills cause pollution problems. They can also result from improper storage, handling and disposal. This includes improper disposal when cleaning pesticide application equipment and storage containers. There can also be leaks at pesticide dumpsites and waste discharge from production facilities.

A biofilter is an in-ground treatment unit that contains pesticide spills. It also degrades the chemicals through microbial activity. (Microbial refers to microbes, living things that can only be seen with a microscope.) Microbial activity can be enhanced under the proper conditions. This research has two goals. One is to develop a biofilter system that adapts to Missouri's soil and environment. Another goal is to make the biofilter feasible for use on small-scale farms.

A greenhouse experiment simulated a pesticide spill using 15-gallon polyethylene drums. There was a capped port at the bottom of each drum. The port opening was covered with stainless steel mesh. A layer of quartz gravel was placed at the bottom of each drum to aid drainage. Forty liters of biomix (a mixture of wheat straw, compost and soil) materials were placed in each drum. There were three treatments. The first used only soil. The second (biomix 1) contained a 2-1-1 ratio of straw-soil-compost. The third (biomix 2) contained a 62.5-12.5-25 ratio of straw-soil-compost. Before mixing, the wheat straw was chopped to 2 cm.

A mixture of herbicides was dissolved in 10 L of water and added to each unit; these included acetochlor, atrazine, pendimethalin and trifluralin. The system was equilibrated for three days. Then the bottom port was opened to drain any excess water. Samples were taken from each biofilter at 0, 7, 21, 49 and 84 days. Each unit was analyzed for herbicide residue.

The use of biofilters to contain and biodegrade pesticides in place might be a cost-effective way to prevent pesticides from entering surface and groundwater.

Energy and Environmental Economics

Dr. Haluk Gedikoglu, Principal Investigator

The Energy and Environmental Economics research program analyzes the socioeconomic factors affecting production systems that create sustainable bioenergy (energy from biological sources: plant or animal waste) farm-level economic analyses of sustainable biomass (living or recently living plants) feedstock (biological and renewable material that can either be used directly as a fuel or can be converted to another form as a fuel or energy product) is conducted. This biomass feedstock is used to develop cellulosic ethanol (a biofuel made from plants). Switchgrass, miscanthus and sweet sorghum are the dedicated energy crops that are analyzed by this research program.

Farm-level producer surveys analyze farmers' willingness to grow these dedicated energy crops. The ongoing analysis shows that current farmers' willingness to grow dedicated energy crops is much lower than predicted. This implies that the cellulosic ethanol production targets set by the Energy Independence and Security Act of 2007 will not be met during the target period.

Another important research finding is that small-acreage farmers, rather than those with larger farms, will be the potential growers of these dedicated energy crops. This will mean a higher cost of gathering biomass feedstock from small and farms that are spread out. This result makes it less economically feasible to produce cellulosic ethanol. Based on the research outcomes of this program, alternative production systems should be examined.

This research received interest from external funding groups as follows: United States Department of Agriculture (USDA) - Agriculture Food Research Initiative (AFRI) - Bioenergy Program, USDA - AFRI - Agriculture Economics and Rural Communities (AERC) Program, USDA - National Institute of Food and Agriculture (NIFA) Capacity Building Grant (CBG) Program and USDA - Higher Education Challenge (HEC) Grants Program.

Hydrologic Processes Controlling Nutrients and Herbicides in the Stream Water of a Claypan Soil Watershed

Dr. Fengjing Liu, Principal Investigator

Information on hydrologic (related to water) processes is needed to understand how contaminants make their way into stream water in agricultural watersheds. (Watersheds are the areas of land where water flows naturally.) A claypan is a continuous, thick layer of clays about 20-50 cm below the surface of the land. And claypan watersheds are especially vulnerable to stream water contamination that is caused by applied fertilizers and herbicides. The claypan blocks the downward movement of water; this reduces the rate of water seeping into the ground. As a result, the water moves laterally over the soil. As the surface water moves, it is highly likely to transport nutrients, sediment and herbicides.

This project is funded by the United States Department of Agriculture (USDA) - National Institute of Food and Agriculture (NIFA). Beginning in 2011, more than 300 samples have been collected at Goodwater Creek Experimental Watershed located near Centralia, Missouri. These samples came from stream water, precipitation, seep flow (water that comes from below and pools in the top soils above the claypan) and groundwater. This study showed that nutrients in stream water chiefly came from seep flow; the contribution from groundwater was about 20 percent. In contrast, the herbicides found in stream water were mainly the result of seep flow; the contribution from groundwater was less than 5 percent. To improve stream water quality in claypan watersheds, it is necessary to protect seep flow. This information is vital to fully understand how to manage watersheds and plan land use. Such knowledge will eventually benefit farmers.

This project has trained a graduate student and a postdoctoral researcher in the field of water quality. Lincoln University's outreach has been enhanced by this study. It has allowed for improved management of the fertilizers and herbicides commonly used by Missouri farmers.

Developing a Least-cost Diet to Produce Bluegill Fingerlings

Dr. Thomas R. Omara-Alwala, Principal Investigator

Bluegill is a cultivated sport fish in the North Central region of the U.S. It is the most popular member of the sunfishes. Recently, bluegill has been identified as a potential food fish by the North Central Regional Aquaculture Center (NCRAC).

Most producers only sell fingerlings or young fish; however, there is an increasing demand for food-size fish. There are no artificial feeds expressly designed for bluegill. This lack is holding back food fish production. Limited information on the bluegill's nutrient requirements makes it hard to develop such feeds.

This research focuses on defining bluegill nutrient requirements. A second aim is to develop least-cost feeds that can be produced commercially. Protein requirements are assessed, as is the protein-to-energy ratio for juvenile bluegills. The current protein source is fishmeal. However, the research seeks to use less costly plant-based protein sources; they would partially replace fishmeal in the diet.

Experiments were conducted in a water recirculating aquaculture system. The diet consisted of dried distillers' grain solubles (DDGS) and soybean meal at several levels. The findings showed that 10 percent DDGS could be included in bluegill diets without affecting their growth or health. Also, a 50 percent soybean meal replacement of fishmeal protein has proved useful. It increased bluegill feed consumption and growth compared to the control diet of only fishmeal. In feeding trials with three commercial diets, the soybean diet outperformed some of the commercial diets that are used for bluegill food fish production. These findings could aid in the development of least-cost feeds to commercially produce bluegill as a food fish. Also, this would make it easier for small farmers and other entrepreneurs to engage in aquaculture. However, more research is needed to fine-tune the feed ingredients for maximum performance.

Mentoring Students in Natural Resources to Meet the Triple Challenge of Managing Invasive Species and Rare Species in a Changing Climate

Dr. Kirsten Stephan, Urban Forester

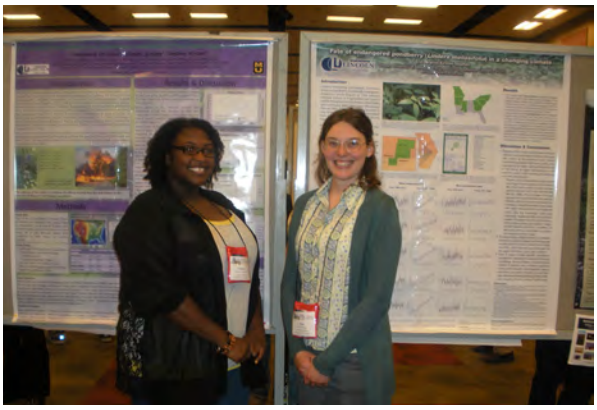


Photo 1. Project participant, Erin Skornia, and the rare species, tall larkspur, in the Missouri Ozarks, 2013.

Photo 2. Simone Johnson and Erin Skornia presenting their research at the botany conference in Boise, Idaho, July 2014.

Natural resources managers face several challenges. First, they must identify and reduce the number of invasive species. At the same time, they have to manage plant species so as to enhance those that are federally listed. This work occurs as the climate changes. In addition, there is a deficit of field-trained botanists. The problem is made worse by the retirement of experienced personnel. This poses a major threat to the integrity of natural resources management nationwide.

This teaching Capacity Building Grant (2012-2015) has three objectives. One is to train students in field botany and associated data management. A second is to strengthen collaborations with state and federal agencies. The last is to enhance teaching and research programs at Lincoln University.

In the summers of 2013 and 2014 (the first two of the three project years), six LU students greatly enhanced their field plant identification skills. This was done while working with experts at LU, the Missouri Department of Conservation or the National Park Service. In the fall of 2014, students were trained in data management. They also attended résumé-writing workshops and conducted a research project on invasive and/or rare species. The results of this research were presented at the local, regional and national level (LU Research Symposium; Missouri Academy of Sciences; Missouri Natural Resources Conference; and Botany 2014, the conference of the American Botanical Society). To date, over 600 species of Missouri flora have been collected, pressed and dried. They will become permanent specimens in the LU herbarium (plant museum). A database of these specimens, along with photographs and other related information, is being created. It will be available online after the project ends. Herbarium specimens will be used for teaching and research.

Faecalibacterium-like Bacteria for Tracking the Agricultural Source of Fecal Pollution in Water

Dr. Guolu Zheng, Principal Investigator

This project ended in FY 2014. During the year, a bacterial, DNA marker was identified that was specific to cattle feces. It was used to develop a rapid, DNA-based method for tracking cattle fecal pollution in water. This grant achieved its goal of using *Faecalibacterium*-like bacteria to rapidly and accurately identify fecal pollution in water that was caused by chickens, swine or cattle. These three breeds of livestock have been the major agricultural sources of fecal materials. They might carry and spread microorganisms (living things that can only be seen with a microscope) that cause disease. These microorganisms are often the source of fecal pollution in water. Methods developed by this project can help to rapidly find the cause of fecal pollution; they can also detect how severe it is. This project provides new tools for making better decisions about where to invest resources to reduce fecal pollution.

The methods have been presented in two peer-reviewed articles; one was published in the respected journal, *Water Research*. A master's degree candidate in environmental science was also trained through this project.

This year, the master's degree program in environmental science benefited from this project. The program now has a greater capacity to address current environmental problems that face Missouri and the nation; the program includes a special focus on the microbiological safety of water and food. The midterm outcome was to help local authorities and the public make decisions about how best to invest funds to deal with fecal pollution; other decisions relate to the type of educational programming that is needed. The long-term outcome can be to reduce human illness that is caused by consuming or contacting water contaminated by feces.

Human Nutrition

Effects of Dietary Omega-3 Fatty Acids on Biomarkers of Cardiovascular Disease in Obese Individuals

Dr. Suman Ahuja, Principal Investigator

Obesity has become a major health concern worldwide. The increasing rate of obesity brings with it more evidence of diet-related health issues. These include hypertension (high blood pressure), type 2 diabetes, cardiovascular diseases (those involving the heart or blood) and some cancers. Research has shown that obese persons are more likely to die at a younger age compared to their lean counterparts. This is mainly due to obesity-related health issues. The goal of this project was to produce scientific information so that health care professionals would have more possible treatments for their patients. This project will aid in health improvement efforts for underserved Missourians and the U.S. general public.

The treatment of cardiovascular health problems might require billions of dollars in the U.S. alone. Therefore, the study attempted to find beneficial effects of dietary omega-3 fatty acids. It is hoped that they will prevent cardiovascular diseases and maintain optimal health, thereby counteracting obesity.

The following activities were completed:

- Designation and setup of a human obesity lab/exercise facility (infrastructure, equipment, staff, etc.)
- Equipment purchase and training
- Application to and approval of the procedures and flyers to promote recruitment by the Institutional Review Board (IRB)
- Active recruitment of obese individuals to take part in the study
- Formulation of special omega-3 fatty acids in various strengths
- Creation of educational handouts, videos, etc., along with nutrition training sessions for possible subjects of the study
- Addition of objectives to study the genetic parameters of obesity in saliva as well as in human blood

After data collection, it was found that more patients needed to be recruited. In the upcoming months, patients will be recruited that have various body mass indices (BMIs) and lipid (fat) profiles. This will allow the investigation of any difference pre- and posttreatment. Also, some of this data has been accepted for presentation at a national obesity conference. Lincoln University will showcase novel treatments in the fight against obesity.

Plant and Soil Science

Biomass Production and Biochar Research

Dr. M. R. Bayan, Principal Investigator

Dr. M. R. Bayan was invited by Kazan Federal University in the Russian Federation to speak about the following: (1) new approaches to soil management; (2) precision agriculture; (3) Geographic Information System (GIS), and (4) organic farming, sustainable agricultural practices and food production.

At the Midwest Biochar Conference, Bayan presented the results of his research on adsorption (adding on) of methylene blue (a chemical compound with a variety of uses) by biochar. Biochar is a charcoal created by pyrolysis (firing at a high temperature) of biomass (living or recently living material). Biochar is added to soil to contain carbon and increase soil fertility. This research collaborated with the Kazan Federal University and the Missouri University of Science and Technology (Missouri S&T).

Bayan gave a seminar at Missouri S&T in Rolla to over 50 faculty, staff and graduate students. He established research ties with three professors. Bayan also gave presentations at the Nutrition, Energy, Environment and Economic Development (NEEED) project gatherings in Jefferson City, Missouri. He discussed sustainable agriculture and the role of biochar in organic food production.

Bayan attended the National GeoTech Center of Excellence in Louisville, Kentucky. There, he received training certificates in the following: GIS automation using Python programming language; Georeferencing with Google Earth™ and ArcGIS®; and succeeding with coordinate systems in agricultural and environmental research.

The biomass production plots at George Washington Carver Farm and the Alan T. Busby Farm were successful. They organically produced switchgrass and miscanthus biomass crops on marginal agricultural land. Bayan mentored two students using biochar, one in St. Louis, Missouri, and one in New York.

Bayan sent an article to the *Journal of Negro Education* to be included in a White House compendium of federally sponsored research carried out at Historically Black Colleges and Universities (HBCUs).

Nitrate and Phosphorus Management in Non-recirculating Hydroponic Culture Systems

Dr. Jonathan Egilla, Principal Investigator

Photo 1. H. E. Anderson J-Series Ratio: Feeder® Injection System.

Photo 2. Collard seedlings 16 days after transfer into hydroponic culture.

Photo 3. Collard plants at market maturity, 80 days after transfer into hydroponic culture.

This study is part of the University of Missoui/Lincoln University MO/LU-HYDROPONICS-5 project, "Nutrient Management in Sustainable Small-scale Hydroponic Systems for Limited Resource Growers in Missouri: Soilless Substrate Effects on Nutrient Element Discharge from Non-recirculating Hydroponic Culture." The goal is to reduce pollution in non-recirculating hydroponic (related to growing plants in water) systems. Specifically, it seeks methods to reduce nitrate (NO_3) and phosphorus (P) pollution.

The J-Series Ratio:Feeder® Injection System (H. E. Anderson Co., Muskogee, OK; Photo 1) was used. It is a precision hydroponic solution delivery system. Collard seedlings were transferred into two-gallon pots. These pots contained either perlite or Fafard® Organic Mix as root-support substrates, the base on which the plant lives. The pots were placed in perlite-Bato buckets; these are special plastic containers used for hydroponic gardening (Photo 2). All plants were irrigated with a complete fertilizer (15N–2.2P–12.6K) through drip emitters. The fertilizer solution flowed to the drain from the root system in either substrate. This leachate run-off was collected weekly. It was analyzed for N, P, potassium (K) and sodium (Na) concentrations. The pH (measuring the acidity or basicity) was measured; electrical conductivity was also calculated. Plants were measured to find their marketable leaf yield and leaf area. The N, K and Na concentrations in petiolar sap (made by crushing the petiole—the slender stalk supporting a leaf) were evaluated.

This research will be used to educate small-scale limited resource hydroponic growers. They will learn how to select crop-specific substrate. This project will provide environmentally friendly methods to improve crop productivity. It will also make inorganic fertilizer use more efficient; this will lead to greater profits and income.

Dr. Egilla attended the 2014 Annual Conference of the American Society for Horticultural Science in Orlando, Florida, from July 27-August 1. He presented the paper "Leaf Growth and Nutrient Element Uptake by Adventitious Roots of Collards in Hydroponic Solution of Variable Composition."

Center for Bioenergy

Dr. Keesoo Lee, Principal Investigator

The Center for Bioenergy's research focused on using microalgae (microscopic algae) to produce a number of products. One was biofuel—solid, liquid or gas fuel made from biomass (living or recently living material). Others were high-value bioproducts—products made from biological resources.

Local weather is a key factor when growing algae outdoors. For successful large-scale outdoor cultivation, it is necessary to use native organisms. However, they cannot grow easily in a place that differs from their origin. Therefore, Lincoln University began a culture collection of microalgal species native to the Midwest. The collection has 275 species. It includes microalgae that are prokaryotic (without a cell nucleus), eukaryotic (with a cell nucleus), unicellular (one-celled) and filamentous (with a threadlike structure). The collection is registered with the World Federation for Culture Collections (WFCC): http://www.wfcc.info/ccinfo/collection/by_id/1071.

The three targeted bioenergy products were biodiesel, bioethanol and biomethane. The bioproducts can be a primary product or a coproduct of creating bioenergy. Four types of bioproducts are being created. The first includes substances that shield ultraviolet (UV) light (light with a shorter wavelength than visible light); these are used to make sunscreen. Another is finding enzymes (catalysts in a biochemical reaction) of industrial importance; these are used to bleach paper, tan leather and make beer and wine. Antioxidants (substances that protect cells from unstable molecules) are used for food supplement pigments, such as astaxanthin and lutein. Squalene, a natural antioxidant food supplement, is another bioproduct.

The Center for Bioenergy's research focus targets anti-GMOs (genetically modified organisms). Metabolic engineering is used, adding or deleting specific nutrients at particular growth points. This drives the cellular process to yield the desired product(s). Hormesis is also used; it applies a very low concentration of toxic chemicals for product improvement. Rare earth elements (REEs), such as cerium, samarium and europium, are used in hormesis. Natural, inexpensive and readily biodegradable (able to be decomposed by living things) materials are also employed to improve the desired products made from algae.

Developing Surface Coating Technology for Preventing the Weathering of Lead-bearing Solids in Soils

Dr. John Yang, Interim Assistant Research Director/Principal Investigator

This research seeks to address the environmental problem of lead (Pb)-contaminated soils that result from mining and shooting activities. The project integrates laboratory and field studies. Its goal is to develop a novel phosphate-based surface-coating technology; this new method could inhibit the weathering of Pb-bearing solids. It would also reduce the health and ecological risks linked to soil Pb. Soil samples from selected shooting ranges and Superfund mining sites in Missouri were collected and treated. This successful treatment coated the surface of Pb-bearing solids from the collected soils with synthetic aluminum/iron (Al/Fe) phosphate compounds. The leaching test used the Environmental Protection Agency (EPA) toxicity characteristic leaching procedure (TCLP). It showed that leachable Pb was greatly reduced by the phosphate-based treatment. The TCLP also revealed that the coating technology on the Pb solids could lower Pb-related health and ecological risks by 95 percent. This would mean a huge reduction is Pb bioavailability (the degree and rate of absorption into a living thing), solubility and leachability.

This study could greatly improve the basic understanding of how lead corrosion and corrosion-inhibition works in soil. The treatment is cost effective, environmentally safe and long term. This new approach would safeguard humans and the ecosystem from risks linked to Pb. The technology this project developed could potentially support the national efforts to restore or remediate hazardous, contaminated sites. It could someday help those Missouri and U.S. residents living in contaminated areas; they would benefit through increased environmental sustainability and quality of life.

One graduate and three undergraduate students gained experiential learning and training in research skills during this project. Five abstracts or conference presentations were made by the principal investigator and students. One research article was submitted for publication in a peer-reviewed journal.

Economics

A Study of Rural Entrepreneurship for Economic Development in Southeast Missouri Counties

Dr. Wesseh J. Wollo, Principal Investigator

Dr. Felix M. Edoho, Professor of Business Administration

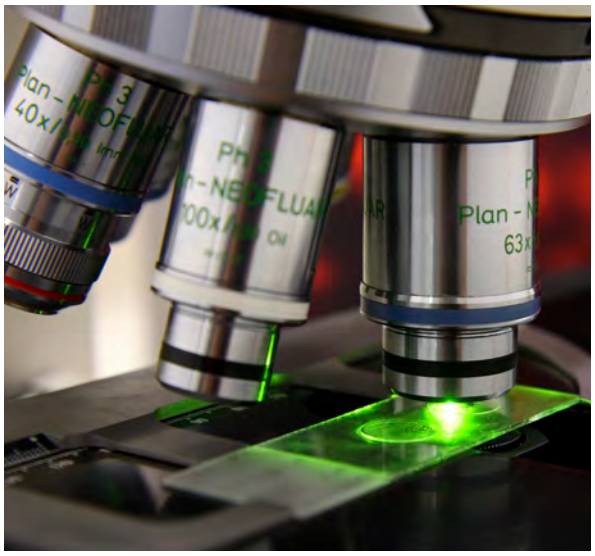
Rural America lacks economic diversification. It needs more small businesses and microenterprises to expand opportunities. Therefore, attention has centered on the role of small businesses and entrepreneurship to increase the economic development of rural areas. Entrepreneurship can boost employment. It also improves incomes and enhances the quality of life.

This project focuses on rural entrepreneurship in the Bootheel in Southeast Missouri. The Bootheel is part of the lower Mississippi Delta, the most economically depressed area in the state and the nation. Great disparities in economic performance exist among the counties of the Bootheel. The western half appears to be performing well economically; however, the eastern half appears to be performing poorly. This project seeks to discover the reasons for these disparities between regions. Possible strategies will be proposed to stimulate entrepreneurial activities to foster economic development.

Out of 444 seniors at three high schools in the Bootheel, 238 (54%) took part in a survey. One high school was in the western half and two were in the eastern half. A total of 205 (86%) of the surveys were usable. Respondents were asked about if they prefer to own a business and where they prefer to work. They were also asked to assess both entrepreneurial qualities and the key knowledge and skills needed by a successful entrepreneur.

The results show a significant difference between the eastern and western halves of the region in students' preferences about business ownership. There is also a significant difference in views about whether an entrepreneur motivates others. A significant difference also exists in the assessment of apprenticeship and in seeing formal education as the key knowledge and skill required to become a successful entrepreneur.

The results imply that high schools should teach about entrepreneurship. Also, policymakers and economic development professionals should encourage programs that develop entrepreneurial skills; they should provide apprenticeship opportunities for students.



Part Five:

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