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Lincoln University Cooperative Extension and Research Annual Report 2010

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LINCOLN UNIVERSITY

COOPERATIVE EXTENSION AND RESEARCH



ANNUAL REPORT

— 2010 —

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Front cover photographs (from top, left to right): tomatoes at Carver Farm, aquaculture staff at Carver Farm ponds, youth practice double Dutch, Boer goat.

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Dear Stakeholders:

Of the many challenges that face us in the 21st century, population growth is one of the most daunting. In the past 50 years, the world has experienced an unprecedented increase in population. As our numbers continue to grow, ever greater pressure is placed on our land, water, energy and biological resources as we seek to provide an adequate supply of food, while maintaining the integrity of the environment. This challenge clearly illustrates the importance of the nation's land-grant universities, with their triple mission of research, extension and education.

Lincoln University, a historically black land-grant institution, focuses its tripartite mission on minority and other limited resource farmers and families, helping them improve profitability and sustainability. In this year's annual report, we highlight extension and research programs that assist this group of stakeholders, as well as other programs that reach a broader audience.

In the following pages, one of the programs you will read about is the Innovative Small Farmers' Outreach Program (ISFOP). Since its development in 2009, the ISFOP has made significant progress, enhanced by assistance from the small ruminant program, the vegetable and small fruit program, and others. Collectively they help to improve the quality of life for people living in the state of Missouri. To be sustainable, farms served by these and our other programs must be economically viable, while at the same time making every effort to conserve our natural resources. Our researchers and extension specialists assist farmers with every aspect of their operation, including soil preparation, care of small livestock and marketing of their products.

In the critical area of building capacity for current and future needs, there have been a number of significant accomplishments over the past year. One source of pride is the completion of the Kansas City Urban Impact Center. This facility, located in the heart of Kansas City on The Paseo Boulevard, provides the first permanent home for Cooperative Extension in the Kansas City area. Prior to the completion of the center, extension programs operated from leased facilities. The new center and its services are featured in this report.

As we have expanded our efforts in the critical fields of environmental science, bioenergy, food safety and animal science, we have recruited some of the best minds in these fields to join our Cooperative Extension and Research faculty. They will be critical to providing answers on how to increase productivity on small farm operations in a sustainable fashion. We welcome them to the Lincoln University family and look forward to their impact on the university and community.

This annual report showcases some of the many activities that we have focused on during the past year. Should you have any questions about any activity or this report, please feel free to contact me at Meredith@LincolnU.edu.

Sincerely,



Dr. Steven Meredith, Dean
College of Agricultural and Natural Sciences

The background of the slide is an abstract composition of soft, out-of-focus circles in various shades of green and blue, creating a bokeh effect. The colors transition from a vibrant green on the left to a deep blue on the right, with lighter, hazy areas in the center.

COOPERATIVE EXTENSION

Ms. Yvonne Matthews
Interim Associate Administrator
and State Extension Specialist

Innovative Small Farmers' Outreach Program

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

Dr. Sanjun Gu, Associate Program Director
Miranda Duschack, Small Farm Specialist
Janet Hurst, Farm Outreach Worker
Susan Jaster, Farm Outreach Worker
Katie Nixon, Small Farm Specialist
Jim Pierce, Farm Outreach Worker
David Price, Farm Outreach Worker
Joyce Rainwater, Farm Outreach Worker
Jeff Yearington, Farm Outreach Worker



Innovative Small Farmers' Outreach Program (ISFOP) staff assesses the needs of eligible rural and urban farmers, including home and community gardeners, through one-on-one consultation and farm visits. After the assessment, relevant technical assistance and research-based information are provided during farm visits, tours, meetings and workshops in the areas of farm planning, book-keeping, production, marketing, grant proposal writing and relevant United States Department of Agriculture (USDA) and state programs. ISFOP helps underserved and minority farmers in 14 Missouri counties. ISFOP staff includes one program leader, an associate program leader, and eight Farm Outreach Workers (FOW). Two of the FOWs are also small farm specialists. The ultimate goal of the ISFOP is to improve farm income and quality of life and to increase farmers' overall well-being while taking good care of the environment.

During fiscal year 2010, ISFOP staff worked in seven counties in the east central region and seven counties in the west central region of Missouri. Staff worked with over 200 limited resource clients, offering nine educational workshops, with a total of 243 participants, on the topics of small ruminant production, cheese making, greenhouse production, high tunnel construction, compost making, starting a home garden and Sustainable Agriculture Research Education (SARE) grant proposal writing workshop. ISFOP staff helped develop two farmers'

ISFOP Farm Outreach Workers helped to build two community gardens and one urban production farm, which provides gardening space to resettled refugees.

markets in economically depressed areas, worked with eight community groups developing and promoting agricultural enterprises, assisted seven farmers in getting accepted into the high tunnel initiative of the Environmental Quality Incentives Program (EQIP) of the Natural Resources Conservation Service (NRCS) and one Wildlife Habitat Incentives Program (WHIP).

The FOWs helped one farmer receive a \$5,000 energy grant, organized and taught two Grow Your Farm (GYF) courses (which lasted nine weeks), and conducted two urban farm tours. They helped build two community gardens and one urban production farm, which provides gardening space to resettled refugees. In addition, the ISFOP published eight newsletters and two fact sheets.

Most outcomes from the technical assistance that the ISFOP staff provided over the course of 2010 cannot easily be translated into dollars. However, an estimated total of \$109,000 in direct profit was reported by 70 collaborating families. Those

revenues were generated by implementing more efficient farming practices, identifying new markets, producing alternative crops, initiating better business planning and record keeping, and diversifying marketing strategies – all advised by FOWs.

One significant social impact was that one of the ISFOP collaborating farmers, Ms. Netley Clay, gained national recognition. Ms. Clay's profile appeared in *Minority Landowner's* magazine, and she attended the USDA's Minority Farmers Conference in St. Louis as a result of ISFOP efforts.

Another social impact was that one FOW helped a recently handicapped farmer continue farming by making a number of mobility enhancements on the farm.

Because of the interactions of the ISFOP FOWs with Missourians, funding from and participation in many government programs increased the social leverage of underserved farmers.



Aquaculture Program

Mr. Charles E. Hicks, State Extension Specialist - Animal Science and Aquaculture

Missouri is the highest fish food producing state in the North Central Region. Providing aquaculture extension services attracts new farmers while providing the needed support to existing farmers. Requests for information from Lincoln University Cooperative Extension's (LUCE) Aquaculture program doubled this year.

Locally produced food is in high demand, and live shrimp can be sold at local farmers' markets. Farmers adopting freshwater prawn techniques can successfully produce an additional food supply for themselves and other rural and local consumers. This positively affected the local economy and also provided high protein food at a reasonable price for limited resource families.

Many Missouri producers have been cultivating sub-adult channel catfish for sale to grow-out enterprises in Arkansas and other southeastern states. The demand for catfish fingerling for stocking ponds still exists, but the market for sub-adult catfish for grow-out has declined drastically. These farmers seek other species they can raise successfully. LUCE's Aquaculture program informed established fish farmers how bluegill will provide an alternative crop utilizing existing ponds. Providing the means to successfully culture an alternative species means saving the family farm for limited resource farmers.

This year, numerous Missouri farmers asked about techniques for raising food-sized sunfish. Requests came from new farmers and those seeking alternative species for their existing farms. Also, six different states inquired about the methods used for the production of sunfish.

The cage verification project cooperated with three farmers at different locations in Missouri. Cages were placed at the Noland Porter farm in Moniteau County, the Glenn Martin farm in

Morgan County, and at James Hawkins' farm in Wayne County. Three hundred pounds of fish were produced. Challenges included a flood at the Martin farm and a fish loss due to pond turnover at Porter's. The final result was that cage culture can be used to raise sunfish on private ponds of farmers willing to learn the procedure and to understand culture technology.

Multi-culture of freshwater prawns and bluegill in Missouri was investigated. Three hundred pounds of fish and 521 pounds of freshwater prawns were raised in two quarter-acre ponds at Lincoln University's George Washington Carver Farm Aquaculture facility. Most notably, multi-culture ponds with freshwater prawns and fish in cages were a viable method of raising two different crops in a single pond. Until then, multi-culture of freshwater prawns and bluegill was not previously reported in Missouri.

Our cage culture verification project showed that the methods were adoptable and little training could produce significant results. The project also identified the need for hands-on training and information transfer through the development of information sheets for distribution to the public. The project further showed that many limited resource farmers in Missouri can successfully raise fish in cages for direct consumption or for sale. The double-cropping project at LUCE showed that raising freshwater prawns and sunfish in cages can easily be adopted by many farmers. Excellent markets exist so farmers can add income or food by adopting the techniques developed during this project. Multi-culture systems add value to existing aquaculture operations.

Providing fresh, locally produced food at farmers' markets stimulates local economy and meets the demand.

Agricultural Economics and Marketing Program

Dr. Emmanuel Ajuzie, State Extension Specialist - Agricultural Economics and Marketing

The Agricultural Economics and Marketing Program's (AEMP) goal is to help small farm enterprises across Missouri become and remain sustainable economically, socially and ecologically. It enhances opportunities for small limited resource and disadvantaged farmers to increase their productivity and profitability through improved marketing strategies. One such opportunity was met through the creation of the cooperative marketing program that especially benefitted those farmers with just a few acres of land. It also draws younger farmers into agriculture and empowers them to become tomorrow's farmers and rural community leaders. It was established in 2000 in collaboration with the Natural Resource Conservation Service (NRCS). The strategy operates in two primary areas, namely in the fruit and vegetable enterprise and the goat and sheep industry.

Between 2000 and 2005, small independent fruit and vegetable producers were given the opportunity to market their small quantities to a big store chain by forming a marketing cooperative. The cooperative collectively sold more than \$450,000 worth of produce in 2003, which was an increase of about 80 percent from the previous year. This would not have been possible if the producers were selling as individuals in small niche markets. Because they had access to a chain store, they were able to improve their farm revenue. Selling through the cooperative gave them some market power that enabled them to maximize profits.

Presently, the program is using past experiences to create a New Generation Growth Cooperative (NGGC) that, when completely put together, will drastically reduce or eliminate the failure rate of these cooperatives. This cooperative has two layers. The first layer is the main cooperative and the second is the limited liability companies (LLCs),

which will become members of the main cooperative. Producers will be members of the LLCs, but not of the cooperative. This new organizational structure removes the cooperative from swings in the moods of individual producers, which contributed to the untimely dissolution of the previous cooperative. The NGGC has been incorporated with the state of Missouri under the name "The Missouri Agricultural Products Cooperative." The articles of incorporation and bylaws have been written. The LLC agreement has also been drafted. The tax identification number has been obtained from the IRS, and LLCs are now being formed. The cooperative will begin operation in spring 2011.

The purpose of the goat and sheep project is to educate producers on the most effective marketing strategies for their animals and provide them with relevant economic rationale for production.

Missouri goat producers continue to benefit from the Internet goat marketing auction, which was founded for them in 1998. Farmers' income from goat operations has tripled since then, and many are entering the sector for the first time for the purpose of farm-product diversification. In the future, the program will improve the demand for sheep and lamb in Missouri and ultimately raise prices. Also, there is an opportunity to create an Internet sheep and lamb auction, just as was done for goat producers.

Onsite visits have shown that farmers who participate in this program have learned the art of marketing and are beginning to enhance their farm income by using more efficient techniques. Farmers who plan to diversify into either goat and sheep production, or the production of fruits and vegetables, are using these strategies. Also, the introductory course in Agricultural Economics at Lincoln University encourages young people to become



farm entrepreneurs, which is the main objective of the marketing program. The program brings young people into agriculture so that they can take over family farms and improve profitability, using enhanced marketing techniques. The program provides information to its participants that will help them to raise the income of the small farmers we serve by approximately 50 percent each year. They will become leaders and influential citizens in their communities and envision buying land for farming to bequeath it to future generations. As profits rise in these areas, more natural art of production will continue to be introduced. Consumption of these products in schools and homes will lead to a better quality of life for individuals and for the society at large.

The efforts made in these two activities have produced significant results. In the case of vegetable producers, farmers have been shown new ways to collectively produce and sell. An NGGC has been established with participating LLCs for effective and efficient production and marketing of produce. Goat and sheep producers were provided with pertinent information to not only enhance their marketing capability, but to improve their farm profits, which have increased by 10 percent from the previous year.

The AEMP would like to recognize the activities of the state specialists who provide the farmers with knowledge of the art of growing fruits and vegetables and producing goat and sheep. They should share in the successes achieved as we record improvements in the profits and overall well-being of our clientele.

Small Ruminant Program

Dr. Charlotte Clifford-Rathert, State Extension
Specialist - Small Ruminants
Mr. David Kiesling, Special Projects Coordinator
Dr. Jodie Pennington, Regional Small Ruminant
Educator, Southwest Missouri
Dr. Helen Swartz, State Extension
Specialist - Goat, Sheep and Small Livestock

The state of Missouri currently produces an estimated 86,500 goats and 79,000 sheep (projected estimates January 2010 NASS/Missouri), which makes Missouri fifth in meat goat production within the United States. With 9,000 dairy goats in the state, Missouri ranks 15th in the US.

Many producers are people finding their way into urban agriculture on small acreage, with the intention of producing smaller livestock compatible with their lifestyle, or they are within an ethnic minority trying to establish a more substantial life-style. This population of producer is diversified not only ethnically, but professionally and socioeconomically. These producers strive to provide a source of food for their families while supplementing their existing income with commodities produced from their farm. More and more families in this category are not adequately educated in animal husbandry, and therefore, make costly mistakes. Many make

basic management mistakes that can be avoided by producers, such as those who attended workshops provided by Lincoln University Cooperative Extension's (LUCE) Small Ruminant program this year.

The LUCE Small Ruminant program is comprised of several sub-programs: Small Ruminant Herd Health (encompasses general health and disease prevention); Parasite Control and Management; Sustainable Grazing and Pasture Management; and Vegetation Control (utilizes the unique nature of goats to control unwanted invasive vegetation).

Workshops were conducted to demonstrate management techniques to producers that they can carry out in order to increase production on their farms and decrease losses when implemented appropriately. Workshops on how to do fecal egg counts and FAMACHA® (a system to evaluate anemia in goats and sheep) certification trainings showed producers how to utilize these management



tools within their small ruminant enterprise. These workshops were very well attended.

Other programs featured disease detection and reduction, management of pregnant does and difficult births, artificial insemination, and marketing. The programs were geared to producers who have a few animals on a few acres.

LUCE's Small Ruminant program also heads up the Goat Industry Community of Practice (CoP) found on eXtension.org, a United States Department of Agriculture (USDA) sponsored web site and knowledge resource, free to the public worldwide. The Goat CoP serves as a one-stop knowledge center that allows producers, educators, and farmers to become educated on issues faced in goat production by providing access to the latest research-based, peer-reviewed information. Topics cover a variety of areas such as reproduction, health (parasites and disease), pasture management, nutrition, breeds, genetics, behavior and how-to video links. The Goat CoP continues to add content by meeting quarterly throughout the year to update the appearance and content on the web-site. Goals of the Goat CoP are to:

1) Provide information from basic housing and management to nutrition, breeds, herd health, reproductive issues, marketing, product safety, and value-added products to goat producers.

2) Provide learning opportunities that are science-based and peer-reviewed.

3) Create collaboration among goat industry professionals resulting in a resource that provides valuable educational materials benefiting the user.

4) Highlight goat industry resources.

5) Provide answers to frequently asked questions (FAQs).

The Goat CoP is an open collaboration between a number of 1890 and 1862 institutions, the USDA, the Missouri Department of Agriculture (MDA) and other extension institutions that are involved in the activities through the web site. The Goat CoP provides education through fundamental basics to producers, enabling them to increase their income from livestock while reducing their loss. Staff from LUCE's Small Ruminant program serve on the Herd Health sub-committee. The objective of this subcommittee is to develop the eXtension web site that will meet the educational needs of goat producers, extension educators and farmers.

LUCE's Small Ruminant program specialists presented "eXtension: the Making of a CoP" and conducted two wet-labs instructing attending producers how to do fecal egg counts (FEC) as a tool in monitoring internal parasites at the first National Goat Conference in Tallahassee, Florida. Also, the



“What’s in Your Toolbox?” segment demonstrated what is necessary to have on hand to efficiently manage health problems until a veterinarian can be contacted.

The Herd Health Parasite Control program discusses management tools to monitor and help control internal parasites in goats and sheep. One producer attended the program in late winter 2010. He acquired a small microscope, took the information gathered at the workshop and put it to use. He began conducting FEC’s on all of his herd, initiated FAMA-CHA®, practiced smart drenching (a practice where you treat only those animals that need it), and diligently worked at rotational grazing. He not only had healthier animals with fewer losses, but also decreased expenses.

Stakeholder input helped us to determine the knowledge areas in which producers and parents of youth in 4-H need basic information on how to successfully produce goats for milk, meat or cheese. They tend to experience more financial loss than gain when first getting started due to the lack of knowledge resources.

Youth learn to manage livestock projects in 4-H and Future Farmers of America (FFA) and then show the livestock at their county and state fair levels. Many attend youth programs sponsored by the Lincoln University agriculture students in cooperation with the LUCE Small Ruminant extension staff. As we enter a more resourceful economy, it is perfect timing to educate this audience so they acquire the knowledge to gain proficient fiscal returns from their livestock, rather than losses. The information taught at these workshops is applied to other livestock species as well.



Another part of the Small Ruminant program is located in the Southwest region of Missouri, in Newton County, which allows for an expansion of educational activities. This office was initiated in December 2009 to serve surrounding counties. Many small ruminant producers are new to the industry and need information on proper management to better maximize their resources. Stakeholders’ needs are addressed by providing information on management systems for production and marketing of small ruminants, allowing greater opportunity for success in their small ruminant enterprises. Most goat and sheep producers have small acreages and are limited resource producers.

Short-term impacts of the small ruminant regional educator in this location include a more informed public, with over 9,000 direct contacts and an estimated 500,000 indirect contacts having been made during the first 10 months. Numerous indirect contacts were made through articles or publicity releases in local, regional, state and national media.

Meetings on marketing and production of small ruminants were conducted throughout the region, including the newly-initiated Southwest Missouri

Sheep and Goat Conference. A small ruminant advisory committee for the Southwest region was also initiated.

The annual Southwest Missouri Sheep and Goat Conference had 75 in attendance. A fecal egg count workshop with 22 in attendance was conducted the night before the conference. As indicated in the evaluation of attendees at the conference, knowledge gained was about double, based on a scale of 0 to 100, generally going from 30-40 before the talks and increasing to 60-80 after discussions were held. Specifically, the presentation on how to get started with small ruminants had an average knowledge score of 34 before the talk and 72 afterwards. Comments were very favorable for both meetings; the average rating for the conference was 4.77 out of 5. The average speaker rating was 3.75 out of 4.

Extensive efforts were made to make ethnic minority producers, especially Native Americans, Hispanics and Asian Americans, aware of the new programs for small ruminants. Flyers in both English and Spanish for the Southwest Missouri Sheep and Goat Conference were distributed at all locations. Flyers were also provided to five churches with services for Hispanics. Seven tribes of Native Americans in the Seneca, Missouri and Miami, Oklahoma areas were visited and also provided with information.



Good working relationships were developed at Crowder College between numerous producers of small ruminants, local FFA chapters, and personnel from the National Resources Conservation Service (NRCS), the Farm Service Agency (FSA) and local banks. Email lists for goat and sheep producers in the area and region have been developed.

Long-term, these educational programs will contribute to improved knowledge of small ruminant management practices. They will lead to greater personal satisfaction and finances for people in the industry, thus improving economic stability in the region.

Vegetable Extension Program

Dr. Sanjun Gu, State Extension Specialist - Horticulture



The Vegetable Extension Program (VEP) serves as the technical resource for both vegetable growers and field horticulture extension specialists from the two land-grant universities in Missouri: Lincoln University (LU) and the University of Missouri (MU). The purpose of VEP is to develop a leading vegetable extension program in the Midwest for vegetable growers, focusing on underserved growers, and to offer professional training on the latest techniques and knowledge for field horticulturists. The VEP staff consists of the program leader, a greenhouse manager, an extension associate, two program assistants, one field assistant and three student workers.

During this past year, VEP received a \$300,000 grant from the United States Department of Agriculture (USDA) for the submission titled "Empowering Socially Disadvantaged Farmers and Ranchers in Missouri with Sustainable Agriculture Techniques and Federal Outreach Programs." This award allowed the hiring of two new program assistants. Other achievements made during fiscal year 2010 include the following:

- Organized in-service education (ISE) for LU and MU horticulturists on vegetable grafting, with more than 40 horticulture educators from

four states receiving training.

- Conducted heirloom tomato, eggplant and seedless watermelon variety trials. Results were published in The Midwest Vegetable Trials Report.
- Organized the 2010 Great Plains Vegetable Growers Conference. More than 600 people attended the conference. This is the largest of its kind in the Midwest.
- Helped organize the Missouri Agri-tourism Conference, the 30th Annual Small Fruit and Vegetable Conference and the 2010 Missouri Organic Conference.
- Offered 12 workshops in commercial vegetable production all over the state on various topics including season extension with high tunnels and food safety.
- Made over 30 presentations on vegetable production and visited over 115 vegetable farms.
- Revised and published the Organic Vegetable Gardening Techniques guide sheet.
- Served as the Missouri editor of the Midwest Production Guide for Commercial Vegetable Growers.
- Offered two field days on variety trials and vegetable demonstration plots.
- Conducted a poinsettia demonstration project and participated in the nationwide University Trials Program of the Paul Ecke Ranch of Encinitas, California.
- Developed, authored and designed approximately 12 plant of interest displays set up at two LU campus locations.
- Conducted the floriculture portion of LU's Future Farmers of America (FFA) judging contest.



Commercial Vegetable farm in Versailles, Missouri

- Provided foliage displays for approximately 25 university events.
- Conducted elderberry variety trials.
- Continued developing positive relationships with University of Missouri Extension (UME), Missouri Department of Agriculture (MDA), Natural Resources Conservation Service (NRCS), Sustainable Agriculture Research and Education (SARE) and many other non-profit organizations.

The VEP had many impacts across the state this year because workshops and conferences provided were based on need assessments from growers. Participation in learning experiences increased the level of knowledge regarding

vegetables. Post-event surveys clearly show they gained knowledge and skills in their production and eventually increased production and income, which was especially true with season extension using high tunnels.

Over the long-term, the VEP will continue to promote locally grown fresh vegetables in terms of both production and consumption. Evaluation of the economic impact of the program to the whole vegetable industry would not be possible without the involvement of the National Agricultural Statistics Service (NASS). The long-term impact will be pictured in the 2012 Census of Agriculture.

Central Missouri Youth Development

Mr. Adrian Hendricks II, Regional Educator - Youth Development



Lincoln University Cooperative Extension's (LUCE) Central Missouri Youth Development program has completed the 2010 fiscal year, promoting a wide variety of programming throughout the state of Missouri. Attention was focused on several initiatives promoting academic and social upliftment.

Childhood Obesity Reduction Program – Show Me the Ropes

The statewide Show Me the Ropes program targeted childhood obesity reduction. The Show Me the Ropes program provided students the opportunity to improve their overall health while developing skills in the sport of double Dutch jump rope. The Show Me the Ropes program focused on different skills and nutritional content for 20 weeks. The program discouraged students from spending large amounts of time without physical activity and encouraged the use of simple tools that promote lifelong fitness. It also increased student knowledge of healthy foods and nutrition choices designed to increase cardiovascular efficiency. The Show Me the Ropes program offered regular classes led by dietitians speaking on the importance of health, inappropriate foods and the long-term consequences of unhealthy food choices. Students demonstrated

knowledge by presenting the benefits of consistent physical education and activity as a lifestyle. Over 300 students increased their athleticism and cardiovascular efficiency through the Show Me the Ropes program this year.



Leadership Development Program – Youth Leadership Retreat

The Youth Leadership Retreat is a 2½ day program that was held at Lincoln University's Alan T. Busby Farm youth development campsite for 30 recommended students from central Missouri. High-school-aged youth were trained on how to take a role in becoming the leaders of tomorrow. The Youth Leadership Retreat was developed to provide essential leadership skills for youth who demonstrate leadership qualities and would benefit from social and behavioral skill development. Mock

job interviews were conducted to give youth interviewing experience and feedback for improvement. Action Plan development training was provided to create strategies specific to their high school and communities. Attendees gained knowledge of effective leadership skills, positive communication and conflict resolution. The Youth Leadership Retreat motivated students toward positive attitudes and comprehensive planning for achieving goals.

The Gathering of Kings – Intergenerational Minority Male Conference

Central Missouri Youth Development also implemented The Gathering of Kings this year, an intergenerational minority male conference that reached over 300 youth around the state of Missouri. Current statistics demonstrate that teens make unhealthy decisions for a variety of reasons, including a lack of purpose or self identity and dysfunctional family environments. Oftentimes, fathers are not in the home, leaving women to raise boys alone without positive male role models. The Gathering of Kings conference helped participants rebuild their families and communities through social and organizational engagement. The Gathering of Kings conference focused on improving the quality of life for minority males of all ages by building on the strengths of minority males, providing cultural survival skills and sharing critical information needed to succeed in a toxic society.



Youth participants in the Hip Hop Camp program learn computer skills.

Youth Literacy and Cultural Education Program – Hip Hop Camp

Another program conducted this year was the youth literacy and cultural education program called Hip Hop Camp. Hip Hop Camp taught youth ages 8-17 to take an active role in becoming the leaders of tomorrow. The program is based on the belief that youth can combat social issues impacting their peers and other teens. Participant had the opportunity to strengthen their individual resolve to remain positive, proactive and progressive in their roles as leaders. Participants learned about Hip Hop culture, African American history, and careers in music, media, and dance. Over 150 youth were trained to develop critical thinking skills, creative writing skills, and other cultural and technological skills.

Financial Education Program

Dr. Wilda Harrison, State Extension Specialist - Financial Education

Lincoln University Cooperative Extension's (LUCE) Financial Education program held a summer enrichment session for at-risk minority youth, ages 7 to 14 years old. The educational training was provided in a fun way in order to teach the youth how to start saving money and develop good financial decision making.

Youth and adults were taught financial education and management skills for life. Sessions included an introduction to banking services, building credit, choosing and keeping a checking account, keeping track of your money, learning to save, save, save!

Those attending learned about their rights as consumers. They were shown how to develop a good credit history and make it work for them. Regarding home ownership, they learned how to know what they are borrowing before they buy. Guidance on making wise choices when shopping and selecting healthy foods based on limited income was one way the participants could relate to and consider their spending behaviors.



The short-term impacts from the program show that the participants gained increased knowledge of banking, setting financial goals, paying themselves first through saving, borrowing basics, "charging it right," paying for college and cars, and keeping a roof over their heads. Those attending the program used their knowledge to change their plans for using money.

At least 70 minority youth from the Bootheel region in southeast Missouri learned how to save and make good financial decisions based on skills they acquired during the program. They learned how to change their spending behavior and became knowledgeable about their use of money. A foundation of being financially literate was established in these young people. We anticipate that when they are adults, they will be improved resource managers.



Paula J. Carter Center on Minority Health and Aging (PJCCMHA)

Ms. Yvonne Matthews, Coordinator

Ms. Deborah Jenkins, Research Assistant

Mr. Donald Peoples, Social Worker

The mission of the Paula J. Carter Center on Minority Health and Aging (PJCCMHA) is to provide leadership in addressing the health, social and psychological needs of Missouri's 50 and older minorities and underserved populations with the support of the Missouri Department of Health and Senior Services and the Office of Minority Health. This is accomplished through education, research-based information, policy analysis and the use of technology as strategic tools.

The PJCCMHA improves the quality of life for Missouri's minority and aging populations by reducing disparities and inequities, and by providing access to health-related care, literacy and behavior. PJCCMHA's programs support health management, health education and diversity. It supports the older population in their efforts to reach optimal health by teaching them how to adopt and maintain a healthier and more active lifestyle and in practicing healthy behavior. The Center conducts several events and outreach activities in order to achieve this goal.

The annual Missouri Institute on Minority Aging (MIMA) is a provider/consumer-training conference dedicated solely to examining the health and health-delivery issues facing minority and underserved, older individuals. It provides evidence-based data to state and local agency professionals in the fields of aging and health, to academic professionals with a focus on aging and health-related topics and to aging consumers.

The theme for the 13th Annual MIMA, held August 3-5, 2010, was "Age Strong, Live Long: Taking Care of Body, Mind and Spirit." It was held at the Capitol Plaza Hotel in Jefferson City, Missouri. Over 150 aging consumers from various parts of Missouri attended. Forty-one concurrent sessions and seven general sessions addressed common body and mind issues. MIMA provided successful





strategies that focused on aging and health-related topics geared toward the 50-plus participants. They participated in comprehensive educational training presentations on a variety of topics, including fraud and financial abuse, HIV prevention, healthy spirituality, stress management strategies and exercises. Almost all attendees said that MIMA offered valuable information, and over 90 percent of the attendees reported that they received life changing, relevant information on issues pertaining to seniors.

The purpose of the Lunch and Learn program is to provide seniors a special setting where they can learn best practices for dealing with issues related to aging as well as decreasing the opportunity for isolation. Seniors receive information on federal, state and community resources for the minority and underserved older constituency. This is accomplished by inviting participants to a lunchtime program in person or through interactive satellite videoconferences. The number of participants for these sessions increased from 20 to 50 through videoconferencing. Sessions take a comprehensive approach to address the needs of the underserved on topics such

as healthcare, nutrition, exercise, transportation, public safety, emergency services, housing, taxation, finance, workforce development, civic engagement, volunteer opportunities, aging and human services.

The utilization of technology for sessions, such as videoconferencing, has been proven to deliver information and services to minority and underserved adults in Lincoln University Cooperative Extension's (LUCE) target areas of Kansas City, St. Louis and southeast Missouri. This year, the following Lunch and Learn sessions were held:

- Coping with the Holiday Blues (Seasonal Affective Disorder) (SAD): Saint Mary's Health Center presented this session, which launched the Lunch and Learn sessions. It educated participants about SAD.
- Fraud and Financial Abuse against Seniors: This topic was presented by the Missouri Attorney General's Office and the Missouri Department of Insurance, Financial Institutions and Professional Registration (DIFIPR).
- Medicare Part D Prescription Enrollment Program: Through established partnerships and collaborations with aging networks, such as Central Missouri Area Agency on Aging (CMAAA) and Community Leaders Assisting the Insured of Missouri (CLAIM), this program conducts the Medicare Prescription Drug Enrollment for minority and disadvantaged older adults by providing assistance in comparing Medicare Part D coverage and/or enrollment in the Medicare Part D Program.
- Newsletter: PJCCMHA produces the Healthy Aging newsletter, which is distributed to over 200 Missouri citizens and serves as a resource for information relative to community outreach, culturally appropriate health care, aging programs, and summaries of minority health and aging research.



- **Senior Health and Fitness:** This session was presented by Jefferson City Medical Group (JCMG) on a do-it-yourself health plan. The presentation explained that it is good for seniors to have knowledge to make personal choices to reduce their health risks, improve quality of life and save money.

- **Mental Health Awareness Day:** LUCE's PJCCMHA and the Missouri Department of Mental Health Division of Comprehensive Psychiatric Services (CPS) sponsored this successful collaborative event. It was held on the grounds of the Missouri state capitol. Over 350 consumers and advocates participated in various educational opportunities.

In support of the aging and health networks, the aforementioned tools and programs geared toward the older, underserved population resulted in steadily increased participation during the year for all other PJCCMHA ongoing initiatives. As Missouri's population continues to age, it reflects the faces of many races and cultural lifestyles. An increased awareness of cultural needs and diversity can only serve as a benefit to the growing underserved populations.

Composting, Green Roof and Green Wall Education and Demonstration

Dr. Hwei-Yiing Johnson, State Extension Specialist - Plant Science

Lincoln University (LU) is the only higher learning institute in the state of Missouri equipped with an in-vessel compost machine enabling cafeteria food waste to be composted. The composting operation and monitoring procedure were developed and later included in the training programs. Composting workshops conducted by LU Cooperative Extension (LUCE) covers topics of waste ingredient mixing, compost monitoring, quality evaluation and applications. A variety of compost machines and bins are displayed at the LU Compost Facility, located at the Alan T. Busby Farm. This demonstrates the commercial grade and do-it-yourself compost bins supporting medium scale and household composting. There are educational posters exhibited to demonstrate composting operations and science-based composting information.

In 2010, LUCE coordinated two statewide events on recycling and composting. One event was the Missouri State Universities and Colleges Recycling Summit, which was supported by a grant from Mid-Missouri Solid Waste Management District Region H. This event provided an opportunity for university recycling coordinators to share knowledge and experience regarding campus waste management. The other event was the In-Service Education (ISE) training workshop titled “Biowaste conversion and composting,” which was supported by the North Central Region (NCR) Sustainable Agriculture Research and Extension (SARE) train-the-trainer program. This event provided composting training to state extension specialists. In addition to aerobic and vermi-composting, other

waste management techniques and methods were presented to the audience including compost tea making, Effective Microbes (EM), biochar and anaerobic bio-digestion. The topics were addressed by specialists from LU, the University of Missouri (MU), Missouri Botanical Garden and experts from private sectors.

Land adjacent to the LU Compost Facility was used to demonstrate compost applications. There is a rain garden, shade garden, wild flower garden and wild edible garden, planted with Missouri native plants and landscaped with support of LU compost. LU compost is also used to support fertilization and maintenance of a green roof and three green



walls, which include a modular green wall, a green screen and a wall made of cables with vines. The establishment of the green roof and green wall was supported by a grant from the Thurgood Marshall College Fund (TMCf) Energy Conservation for Faculty award in 2010. The grant supported the purchase of temperature and water-level monitoring devices, used to measure the effects of the green structures on building insulation and to monitor storm water run-off.

Training materials on design, construction and maintenance of above green structures were developed and printed on large posters for educational purposes. Site tours were offered to the community to show the green structures and the positive impacts on energy conservation, biodiversity, building structure sustainability, public health and environmental quality improvements.

The 2010 workshop surveys indicated that LU training assisted in the increase of knowledge and awareness of composting and green structures. With increased composting activity, waste and its related pollutants would be



Green wall at Bubsy Farm

reduced in landfills. The conversion of waste to compost, a useful soil amendment, would increase as a result. In conclusion, composting and building green structures will have positive and long-term impacts on natural resources, public health protection as well as environment quality improvements.



Center for Community and Leadership Development

Mr. Darrell Martin, Research Assistant



The Center for Community and Leadership Development program (CCLD) serves communities that struggle with addressing social and economic challenges. With proper coaching and some guidance from CCLD, community stakeholders are able to chart new visions and attain new goals.

The city of Homestown, Missouri, has a long history of a lack of interaction and involvement. In 2010, the CCLD reviewed the needs and desires of this small, rural and underserved community in southeast Missouri and began assisting them with fundamental first steps by planning the “Together We Can” symposium. A direct result of the symposium, and CCLD working together, was that the mayor could navigate her community in a direction to improve the quality of life for the citizens of Homestown. During the past year, a new fully operational city hall opened and a retired judge was hired to enforce city ordinances. A police officer was also hired to serve and protect the community. The CCLD is collaborating with the United States

Department of Agriculture (USDA) Rural Development division to renovate an historical community center that was erected in the 1940s during the start of public housing.

The symposium became the platform for community leaders and stakeholders to address their issues. It brought together underserved and underrepresented communities and leaders to share informational resources in order to develop goals for their communities. It created involvement within this community and other organizations, and resulted in long-term, sustainable impacts on the socioeconomic and environmental well-being of the community.

In the future, the CCLD seeks to increase the capacity of the community, allow its leaders to coalesce resources and better address the issues of the community.



Native Plants Program

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



The Native Plants Program (NPP) promotes the use of native plants for conservation in rural and urban settings. It increases awareness about their value-added potential for consumption and/or to generate income for underserved people, including small farmers, producers, landowners and others. NPP personnel organize and participate in field days throughout Missouri, offering seminars and workshops on a wide array of topics related to Missouri native plants.

This year, funding was received to establish outdoor laboratories. Two 1890 Institution Teaching, Research and Extension Capacity Building Grants (CBG) from the United States Department of Agriculture (USDA) were submitted. The award allows the program to run a community garden and establish demonstration native plants gardens.

A Native Plant Outdoor Laboratory (NPOL) was established in Marshall, Missouri, at the Marshall Community Center. Another NPOL is underway in Jefferson City, Missouri. The popularity of the

program is obvious by the increase in requests from groups like Master Gardeners and Master Naturalists requesting workshops and presentations. In fact, a Native Pollinators workshop brought more than 100 participants from across Missouri!

The Community Garden at Dickinson Center on Lincoln University's (LU's) campus was established with traditional and special ethnic vegetables and native plant gardens for pollinators, and for food consumption.

Through the Native Plant Outdoor Laboratory and workshops, participants learned a wide array of information and can benefit in many ways:

- During pollinator workshops, they were shown how native plants provide food and cover for a diversity of native pollinators. They also learned that there are native bees that may be more important than European honey bees for pollination.
- Native plants will be adopted by farmers so the number and abundance of pollinators will increase.
- By becoming more familiar with native plants and their uses, groups such as Master Gardeners and Master Naturalists help increase awareness about native plants among the people they serve.
- The knowledge farmers and landowners gained will enrich their own lands.
- Farmers in urban or rural areas will produce native plants for profit.
- More people will consume edible native plants.
- More native plants will be established in gar-



Primrose in full bloom at the Native Plants Outdoor Laboratory at Allen Hall on Lincoln University's campus.

dens, which will improve biodiversity in urban areas.

Two annual field days organized by the NPP were done in collaboration with other Lincoln University Cooperative Extension and Research (LUCER) faculty and staff. Both provided educational activities that were fun for children and adults while integrating nature, the environment and agriculture. Other events were also sponsored by LUCE's NPP:

- "In Touch with Nature" at LU's Alan T. Busby Farm in Jefferson City. Attendance increased from 40 people in 2008 and 70 in 2009, to more than 200 in 2010.
- "Nature and Agriculture in the City" at Manheim Community Garden in Kansas City. With the participation of neighbors and children, it was sponsored by the Center for Equitable Education (CEED), which promotes environmental education for underserved children.

Collaborative efforts continued and increased this year with the non-profit organization *Amigos del Arbol in El Salvador*, University of Missouri-Extension (UME) and other nonprofit organizations.

Other highlights for the year include the

publication of two articles related to native cool season grasses in 2010. And, for the past three years, the NPP has been a member of the planning committee for the "Missouri Women in Ag" conference held in Marshall, Missouri.

Direct participation in gardening with native plants improves the well-being of youth and adults through exercising while enjoying the outdoors. Underserved families are able to consume healthier food and improve their lives while receiving additional income from value-added products they grow using Missouri native plants.

Closed gentian in bloom at the Native Plants Outdoor Laboratory at Allen Hall on the Lincoln University campus.



Fort Leonard Wood Outreach Office

Mr. Andrew Cempa, Extension Liasion

The Lincoln University Cooperative Extension's (LUCE) Fort Leonard Wood (FLW) office cultivates contacts within the greater FLW community, including outlying areas and affiliated populations, in order to develop both funded and unfunded program opportunities for military populations in central Missouri.

The office creates relationships in the Garrison Command area to establish a foundation for more programs. This allows us to obtain agreements that move toward a partnership in regard to the pursuit of funded programming for LUCE and related programming from various other sources, such as the United States Department of Agriculture (USDA)/Department of Defense (DoD) joint family and community opportunities. Programming occurs in conjunction with the FLW Directorate of Family and Morale, Welfare and Recreation (FMWR), and LUCE specialists.

During fiscal year 2010, the LUCE FLW office made significant progress in identifying and contacting appropriate leaders who would likely influence the overall purpose of the program. Family support leadership in the FMWR agreed to further discuss shared and jointly funded programming, as well as the pursuit of short-term initial projects in the family support venues on and around the installation.

We partnered with the Drew L. Pippin Youth Activities Center in a collaborative effort to discuss ongoing projects that will be fruitful in the coming year. One project is to pursue joint programming within the context of existing opportunities either conducted on the installation or at other venues that LUCE has planned for fiscal year 2011.

Another project is to create a formal link between programs within FMWR to allow the joint pursuit of funded opportunities that so far have been unavailable due to lack of an agreement and systems in place that would expedite comprehensive processing of funding opportunities.

The LUCE FLW office has obtained buy-in from several FMWR offices, such as Family Support and Youth Development, in order to create a collaborative program. It will mutually benefit opportunities seeking funding for the creation of new and innovative family support programs (all spectrum, school-age through seniors) to combine our collective talents and skills.

Continued interaction with the FLW Family Support Agency and its subordinate units will find common opportunities to bring the teams together. Long-term effects will be in the area of children and youth services. Jointly funded and unfunded programs with LUCE programs will be held both on and off the installation/campus when opportunities arise.

The LUCE FLW office participated in many associated events and processes, ranging from National Science Foundation Jr. and Sr. High School Science Fairs to participation in meetings and symposia related to family and wounded warrior programming that may provide future opportunities. We provided assistance in gaining funding through military programs in military education (training and awarding college hours for skill training programs) and disaster response studies and recommendations to the installation, among other topics.

Kansas City Urban Impact Center

Ms. Marion R. Halim, Regional Coordinator

Nina Grimes, Secretary III

Arthur Jackson Jr., Outreach Worker

Will Parker Jr., Outreach Worker

Joanne Smith, EFNEP Program Assistant

Keverick Wilson, Area Educator

Tina Wurth, Regional Educator

The Kansas City Urban Impact Center (KCUIC) targets limited resource and minority audiences in the Kansas City area and provides survival skills in workplace preparedness, youth-at-risk, assertiveness, money management and personal health. In June 2010, the Center gained a permanent location when it moved into a new building located at 1028 The Paseo in Kansas City, Missouri. Within a week of relocating, the KCUIC hosted the annual Summer Leadership Academy. Throughout 2010, KCUIC staff worked to improve the lives of their target audience through workshops, training sessions and mentoring activities.



The 4-H Youth Development program creates environments in which youth are valued and become contributing members of the community.

Following is a brief summary of the main activities of 2010:

- **4-H Programs:** 4-H is a family-community effort, supplementing and complementing the mission of the home, church and school for the positive development of youth. This year, 4-H youth, in the Kansas City area, set up a Facebook page to highlight activities and upcoming events. It encouraged youth to join the Kansas City 4-H program. The centerpiece for the program is the Youth Leadership Academy. This year, one staff member served as a representative to the Missouri state 4-H planning board. Additionally, one young man served on the 4-H Youth Executive Council.
- **The Obesity Reduction Program:** This program, now in its fourth year, was developed to fight obesity within the urban core of Kansas City. It provides nutritional and exercise programs in order to assist youth in understanding the harmful effects of childhood obesity. This year the focus was on physical exercise through jumping rope and accurate nutrition information. The youth were also shown how to maintain focus, keep energized and stay motivated as they improved their physical health. One-hundred-twenty youth participated in the rope jumping program. At the beginning of the program, no child was able to jump for more than forty-five consecutive seconds. By the end of the school year, 85 percent of them were jumping for three consecutive minutes.
- **Mentoring:** The Mentoring program prepared youth to be productive members of society through structured, ongoing positive relationships with caring adults. Staff and community volunteers served as youth mentors to 30 participants. Through workshops teens were educated about the negative and deceptive practices behind some music and television. An emphasis was made to identify and focus on youth living



The Kansas City Urban Impact Center had over 300 direct contacts with youth this year. Through the Center's work with public and private schools in Jackson County on health issues, another 1,500 indirect contacts were made.

with critically limited resources. Educational workshops and seminars were also offered to people living in homeless shelters. Workshops focused on nutrition education, parenting and budgeting. Over 20 families were involved in the workshops. They reported being most appreciative of learning how to stretch their financial resources. This work was particularly rewarding.

One of the greatest programmatic successes was reached through the Academic Enrichment program. Several youth were identified

as not being likely to complete 11th and 12th grade. All of the young people enrolled in the academic enrichment program graduated from high school and are now either pursuing a college education or seeking gainful employment. In addition, the number of in-school and out-of-school suspensions decreased by over 30 percent.

- **Agriculture, Food and Nutrition:** The agriculture program provided hands-on educational activities. Eighty-six people of all ages attended these four workshops: Preparing the Earth for Food; Gardening 101; Edible Native Plants; and How Does Your Garden Grow? Training and technical assistance was provided on food production, the environment, and how to manage natural resources. Youth and adults were taught basic gardening skills through hands-on activities. They planted vegetables and edible plants such as sunflowers. Youth who had never worked in a garden learned how plants grow, where food comes from and what animals are important to the environment.

Through the Expanded Food and Nutrition Education Program (EFNEP), 212 participants developed a file to maintain low-cost recipes. Kindergarten and first-grade children learned the food groups by color and were able to identify them using the MyPyramid.gov website. Second- and third-graders learned to identify animals based on characteristics that were given in what they ate. University Academy and Garcia, Longan, Troost and Trailwoods elementary schools participated with 315 youth attending. Pre- and post-testing showed that the participants learned about My Plate portion awareness and the consumption and identification of more fruits and vegetables.

Southeast Missouri Outreach Centers

Ms. Brenda Robinson Echols, Regional Coordinator

Caruthersville

Patricia Cagle, Program Assistant
Adrienne Hunter, Regional Educator
Dawn Jordan, Program Assistant

Lilbourn

Darvin Green, Program Assistant
Sherry Maxwell, Program Assistant
Tamela Strayhorn, Program Assistant
Ruth Thomas, Program Assistant

Malden Bootheel Youth Museum

Matt Kronz, Regional Educator

Sikeston

Felecia Anderson, Regional Educator
Ciera Andrews, Program Assistant
Rosie Davis, Program Assistant
Brenda Robinson Echols, Regional Coordinator
Kenneth Hollowell, Community Outreach Worker
Tiara Riggs-Butler, Secretary

Lincoln University Cooperative Extension's (LUCE) mission is accomplished in Southeast Missouri through three outreach offices. The main office is in Sikeston. Two other offices are located in nearby Lilbourn and Caruthersville. Though each office functions as part of an overall team, each also offers unique programming tailored to meet the needs of its specific area residents.

This year, after school tutorial programs were offered in several communities for kindergarten through eighth grade. Participants received homework assistance, computer skills training, and individualized tutoring in reading, math, social studies and science. Over 100 students were served.

The Summer Enrichment program provided a safe, educational outlet for youth on a daily basis. The focus was on experiential learning, character development, theatre, dance, recreation, nutrition and fitness. Approximately 200 youth benefitted



Summer Camp

from the program between June-July 2010.

The Science, Engineering and Technology program was offered in partnership with the Bootheel Youth Museum and AmeriCorps, who have provided educational hands-on workshops to students throughout the Bootheel area of Missouri since 2007. Some of the workshops held included Pond Science, Aerodynamics with Paper, Simple Machines, Rocket Science, Bird Houses, Science Chef, Newton's Workshops, and Earthquake Science. Over 2000 contacts were made.

Teen Talk, offered through area schools and community organizations, is a teen pregnancy prevention program that empowered teenagers within the community through education, peer-to-peer counseling and mutual support. The program reached over 800 students this year.

The Youth Agriculture Conference was a two-and-a-half-day conference providing information regarding opportunities and careers in agriculture to approximately 150 high school-age students.

Missouri community gardens were established in Caruthersville, Charleston, Malden and Sikeston. Youth learned how to plant, maintain and harvest fresh vegetables.

The Youth Leadership program prepared youth for college by showing them how to become active in their communities and how to become more ef-

fective leaders. Money Smart and Teens Against Tobacco curriculums were used to train 65 students.

The Summer Youth Work Experience program trained 25 high school students on job skills and on how to gain real work experience.

The Sojourner Project and HIV/AIDS Awareness program provided educational workshops to foster intergenerational communication among African American females. Sixty mothers and their daughters attended.

The Cultural Awareness program offered stepping, singing, drama, hip hop dance and ballet to improve self-esteem, fitness, poise and teamwork, and during Black History month in February, the richness of African American culture was celebrated through various programs. Approximately 500 students participated in both programs.

The youth development program, Kid's Beat, utilized club leaders and volunteers. They meet periodically to work with local youth in their communities in order to educate them. Through this program, the following activities were sponsored:

- HIV/AIDS/STD Awareness Program Spring Bling: The program was held in the spring to teach students about the threat of HIV/AIDS in the African American community and the devastating affect it can have. Approximately 500 participated.
- Volunteer Leadership Conference: Kid's Beat hosted this three-day conference that trained 50 club leaders and volunteers to work with youth.
- Night of the Stars: This program recognized the efforts of the club leaders and volunteers that assisted with the Kid's Beat program on the second Saturday of September with over 300 participants.
- Back-to-School Program: Fall into Fall focused on encouraging youth to continue their education after high school and to achieve higher grades. Approximately 500 students attended.
- The Losing and Learning with Lincoln Summer Enrichment Program was an opportunity to teach healthy behaviors to youth. Kid's Beat developed this program to teach healthy lifestyles for children, including nutrition and physical activity. Seventy-five students participated.

Youth Field Day

During youth field days, students learned about the dangers of illegal drugs, tobacco and alcohol use. Goal-setting techniques were studied. Students learned how to make positive decisions, become community leaders and improve academically. Over 1000 participants attended.

Community and Leadership Development

The Computer Literacy Program provided area residents with the opportunity to improve their computer skills. The program allowed participants to access the Internet. Students were able to complete homework assignments during open computer lab hours.

Through the Technical Assistance program, ongoing technical support was offered to community faith-based organizations. Leaders received help with grant proposal development, leadership training, policy and procedural training to help improve community and economic development.

The Intergenerational Program offered senior citizens over the age of 50 opportunities to discuss issues. They learned to take actions vital to improving their lives as well as the lives of others in the 21st century. The program focused on

The Southeast Missouri Outreach Centers provide many programs that foster healthy youth development.



Youth learn the value of team work while playing tug-of-war during Youth Ag Camp.

intergenerational leadership, volunteerism, education, health and other issues that have an impact on their lifestyle. There were 250 participants.

Human Nutrition

- The Expanded Food and Nutrition Education Program (EFNEP) is a nutrition education program that worked with low income families to improve their eating habits. Participants learned how to incorporate more fruits and vegetables into their diets and increase their physical activity. Approximately 100 families were served.
- A Nutrition and Fitness program was offered to area Head Start schools to teach preschoolers the value of eating healthy and the importance of physical fitness to prevent childhood obesity. Two hundred students participated.
- Double Dutch was offered for elementary and junior high students to increase physical activity. The youth competed statewide at the Show Me the Ropes competition on the campus of Lincoln University in Jefferson City, Missouri, during May. About 70 students were served by the program.

"I was raised on a farm in New Madrid County, Missouri. Along with choir, band, dance lessons and church, Lincoln University Cooperative Extension (LUCE) programs were something my mom insisted that my twin sister and I had to be involved in. My mom said being idle was unacceptable. She believed there was always something new we could learn, and she was going to position us to be taught."

"LUCE let me practice how to make presentations and lead groups. Extension staff from the Bootheel area in southeast Missouri and Lincoln University's Jefferson City campus let us know they were concerned about us and would be there to support us as we embarked on new adventures. As we undertook the challenges of our first semester of college, the experiences my twin and I had through our involvement in LUCE, especially in the area of leadership development, helped us not just survive, but to thrive."

"I am Ashley Wells, and I thank Lincoln University Cooperative Extension for what it has done, and continues to do, in my life."

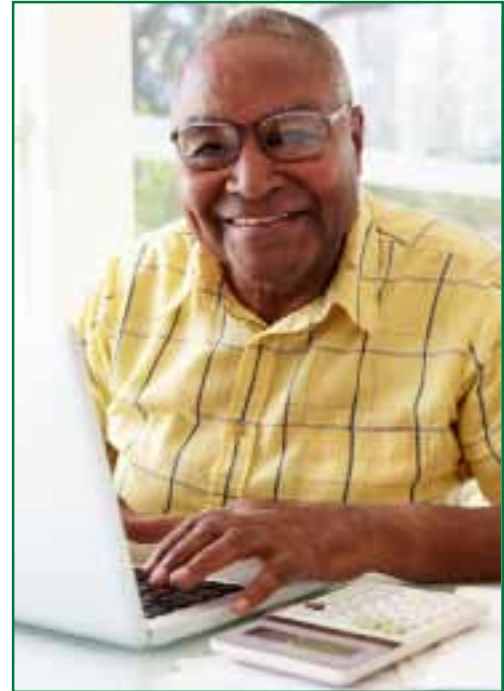
St. Louis Urban Impact Center

Ms. Patrice Dollar, Regional Coordinator

*Jacqueline Anderson, Program Assistant
Ernest Bradley, Program Assistant
Shauneille Connor, Community Outreach Worker
Jennifer Davis, Nutrition Associate
Karen Davis, Regional Educator - Horticulture
Kandice Goodman, Administrative Assistant
George Little, Community Outreach Worker
Fran Long, Nutrition Associate
Marla Moore, Regional Educator
Gus Robinson, Area Educator*

Lincoln University Cooperative Extension's (LUCE) St. Louis Urban Impact Center (SLUIC) provides research-based educational outreach programs to Missouri's hard-to-reach at-risk populations. It enhances the quality of life for its residents by facilitating programs that promote self-sufficiency, economic stability and community empowerment that will enable them to develop labor market skills leadership and social competency. It accomplishes these tasks through collaborative efforts with community stakeholders, leaders and residents. Here are highlights from the programs that enriched the St. Louis community during 2010:

The St. Louis Urban Impact Center (SLUIC) delivered comprehensive, ongoing programs to over 250 people. All programs, from urban agriculture to entrepreneurship, are intended for human development across the lifespan. Whenever possible, programs are designed to be intergenerational.



Workforce Development Programs for Seniors and Youth

ServSafe® has a workforce development program component that focused on enhancing the education of senior citizens, enabling them to return or enter into the workforce. The ServSafe® program is a food service training partnership held at LUCE's SLUIC in collaboration with the American Association of Retired Persons' (AARP) North St. Louis County office. ServSafe® provides short-term training that prepares participants to acquire unsubsidized employment in the food service industry. Participants completed three weeks of training, seven meeting sessions and 21 hours of ServSafe® coursework. The program was designed to assist senior citizens getting back into the workforce while at the same time reducing their level of receiving subsidized income. The senior citizens are at least 55 years old and referred by the AARP's Senior Community Service Employment Program (SCSEP). At the end, an exam is given so that participants become state certified. The AARP provides ServSafe® class participants with a bi-weekly income. The seniors who participated enhanced their



professional knowledge. It gave them an opportunity to increase their ability to stay productive as well as gain quality employment. This program improves their chances of applying their independent living skills as working members of society. This was the first program of such high caliber experienced in collaboration with AARP. It started with 10 participants. At the end, six of the remaining nine successfully completed the coursework and exam. They are now state certified in Missouri to serve food in the commercial industry.

LUCE's youth component of the Workforce Development program involved high school and college students. They were taught the basics of professional etiquette, basic office skills, customer service, filing and typing. The students were recruited through the in-school and afterschool programs such as the leadership academy. SLUIC provided basic computer literacy training, consumer safety, personal hygiene regarding food service, customer service training and SCSEP seasonal volunteer paid internships from the AARP.

Pharmacy Medication Program

Sometimes seniors take medications not knowing what the effects are or if it actually works for them. In the Pharmacy Medication Program, seniors are able to ask questions and find out ways to better store and dispose of their old medications. They

learn the best time to take their medications, how much to take, and what happens if it makes them ill.

The seniors enjoyed coming into the center to voice concerns directly to a licensed pharmacist. They came to the sessions with their questions, and some even brought their prescriptions with them to ask specific questions. The seniors looked forward to exchanging knowledge with one another, too, and the pharmacists enjoyed speaking about medications to them. Two sessions were provided and were well attended. The seniors learned how to save money and find out what the best choices are when purchasing medications.

Everyone asked questions and participated in the sessions. They also enjoyed getting together for general fellowship.

HIV and AIDS Prevention

In 2009 the Center for Disease Control reported that the rate of new HIV infections among black women was 15 times than that of white women, and over three times the rate among Hispanic/Latina women.

In partnership with several community organizations concerned about potential devastation by AIDS in communities of people of color, two all-day conferences focusing on HIV and AIDS

were planned and conducted. One conference focused on youth only and the other on females from age 13 to senior citizen. Partners included the Missouri Office of Minority Health, the Telios Project, Washington University in St. Louis and the St. Louis African American AIDS Alliance. The focus of the youth conference was prevention. In addition to discussing prevention and treatment, the conference provided testing for HIV and AIDS. Over 150 youth and adults attended the conferences.

College Assurance Program

A component of the College Assurance Program is Men on Business. The Men on Business program supports male high school students. They are provided information and resources about how to enter and complete college. The skills they learn, along with assistance from mentors, aide in the transformation from boys to men. After significant accomplishments this year, the young men were able to attend the 25th Anniversary of Minorities in Agriculture, Natural Resources & Related Sciences (MANRRS) at Disney World in Orlando, Florida. They were also the recipients of the regional community engagement award from the Kellogg Foundation. The program changed social behavior which resulted in positive outcomes. Over the long-term, impacts will be reflected in cultural change as more youth go from kindergarten to earning a college degree, as all participants are expected to understand this process.

Community Gardens and Urban Farms

With minority and limited-resource farmers losing their land at a rate of two-and-a-half times greater than their white counterparts, the Community Gardens and Urban Farms programs taught and assisted small-acreage farmers in managing their natural resources so they could develop sustainable systems and enterprises. This year, the program was expanded to address the needs of local “food deserts” by

transforming vacant land into productive green spaces for urban farms, community gardening, gatherings and educational programming. Through broadening partnerships between urban and rural farmers, and business and service organizations, the programs have increased access to healthy, affordable, locally-grown food, enhancing the quality of life and economic sustainability in St. Louis. The program employed best practice principles by providing rural and urban farmers with educational, technical and vocational assistance to develop sustainable farming systems.

The technical assistance in crop production, scheduling, planting and harvesting that was provided will ensure that the 2011 season shows an increase in the volume of food produced and sold at market. The collaborative community food networking group has demonstrated success through the “Grow Your Farm” and “Growing Gardeners” programs sponsored by LUCE, University of Missouri Extension (UME) and Gateway Greening.





St. Louis Urban 4-H Leadership Academy and Summer Enrichment Program

This fall, students participated in the annual St. Louis Urban 4-H Leadership Academy. The program was held in conjunction with UME. Every other Saturday, students from various parts of the St. Louis metropolitan area gathered at the SLUIC. They were introduced to the 7 Habits of Highly Effective Teens concept. Students used the habits to form solutions for real-life situations. The program finale was a weekend retreat to Lincoln University's Alan T. Busby Farm youth development campground. They went through various leadership training sessions and used skills they learned in the previous sessions. Through this program, the students learned to work as a team, the value of good decision making, how to focus on school and the importance of going to college or continuing their education.

During the Summer Enrichment Program in June 2010, the "Art with Us" event was introduced to the students. Based upon their interests, photography and acrylic painting were the two types of art media they learned about. Students used captions, poetry, journaling and displaying photographs as part of their final project.

For the acrylic painting sessions, students completed one portrait and a landscape painting. Students painted on a rectangular canvas, orienting their work landscape or portrait by rule. Images were transferred using the grid method. A three-phase approach was taught during the painting process. Students then visited the St. Louis Art Museum galleries to study the surrounding architecture in relation to the principles and elements of art. Each student in the painting session displayed at least one of his or her works framed for exhibition at the Summer Program Finale.

Through hands-on experimentation, the youth learned how to look for a subject and relate to the subject being photographed and how to tell a story about their family heritage through the lens of a camera. During the photography session, the youth displayed photographs they had taken over a two-week period at the Summer Program Finale. The photographs, stories and associated activities were used as an encouraging learning tool, contributing inspirational ideas towards their futures as they gain knowledge from reflecting on their rich heritage. The students were impacted by the importance of understanding artistic principles and elements as well as learning about careers available to them in the arts.

Extension Program 2010 Contacts

Lincoln University Cooperative Extension (LUCE) presented or participated in 70 different programs throughout the state of Missouri in 2010. These programs included 98 activities designed to motivate, educate, and challenge all participants. Each program and activity was presented multiple times throughout the fiscal year. This resulted in a large number of contacts with both adults and children.

| Lincoln University Cooperative Extension Contact Information | | | | | |
|---|------------------------------|--------------------------------|------------------------------|--------------------------------|---------------|
| | <i>Direct Adult Contacts</i> | <i>Indirect Adult Contacts</i> | <i>Direct Child Contacts</i> | <i>Indirect Child Contacts</i> | <i>Totals</i> |
| <i>Total All Contacts</i> | 12,300 | 15,361 | 23,887 | 12,336 | 63,884 |
| <i>Total Adult Contacts</i> | 12,300 | 15,361 | | | 27,661 |
| <i>Total Child Contacts</i> | | | 23,887 | 12,336 | 34,223 |
| Total | | | | | 63,884 |

| Lincoln University Cooperative Extension | | |
|---|-----------------|-------------------|
| Programs and Activities | | |
| Discipline | Programs | Activities |
| <i>Family and Youth Development</i> | 28 | 28 |
| <i>Community Development</i> | 22 | 31 |
| <i>Plant Science</i> | 8 | 20 |
| <i>Animal Science</i> | 12 | 19 |
| Total | 70 | 98 |

Extension Demographic Data

Note: LUCE gathered demographic information from participants who voluntarily provided it.

MALES

| Age | White | Native Hawaiian | Native American | Latino Hispanic | Black | Asian | Totals |
|--------------|-------|-----------------|-----------------|-----------------|-------|-------|--------|
| 50+ | 548 | 10 | 12 | 56 | 497 | 7 | 1,130 |
| 18-49 | 763 | 10 | 12 | 60 | 922 | 10 | 1,777 |
| Less than 18 | 2,548 | 10 | 10 | 202 | 3,117 | 33 | 5,920 |
| Totals | 3,859 | 30 | 34 | 318 | 4,536 | 50 | 8,827 |

FEMALES

| Age | White | Native Hawaiian | Native American | Latino Hispanic | Black | Asian | Totals |
|--------------|-------|-----------------|-----------------|-----------------|-------|-------|--------|
| 50+ | 355 | 10 | 12 | 56 | 1,352 | 7 | 1,792 |
| 18-49 | 931 | 10 | 12 | 60 | 1,528 | 15 | 2,556 |
| Less than 18 | 2,575 | 10 | 10 | 202 | 3,454 | 21 | 6,272 |
| Totals | 3,861 | 30 | 34 | 318 | 6,334 | 43 | 10,620 |

MALES and FEMALES

| Age | White | Native Hawaiian | Native American | Latino Hispanic | Black | Asian | Totals |
|--------------|-------|-----------------|-----------------|-----------------|--------|-------|--------|
| 50+ | 903 | 20 | 24 | 112 | 1,849 | 14 | 2,922 |
| 18-49 | 1,694 | 20 | 24 | 120 | 2,450 | 25 | 4,333 |
| Less than 18 | 5,123 | 20 | 20 | 404 | 6,571 | 54 | 12,192 |
| Totals | 7,720 | 60 | 68 | 636 | 10,870 | 93 | 19,447 |

The background of the slide is an abstract composition of soft, out-of-focus circles in shades of green, teal, and blue, creating a bokeh effect. The circles vary in size and opacity, with some appearing as bright highlights and others as softer, more diffused shapes. The overall color palette is cool and natural, suggesting a connection to nature or science.

COOPERATIVE RESEARCH

Dr. Frieda Eivazi, Associate Research
Director and Head, Department of
Agriculture and Environmental Sciences

New Nanoscale Biosensor for Detection of Luteinizing Hormone in Small Ruminants to Determine Optimum Breeding Time

Dr. Zahra Afrasiabi

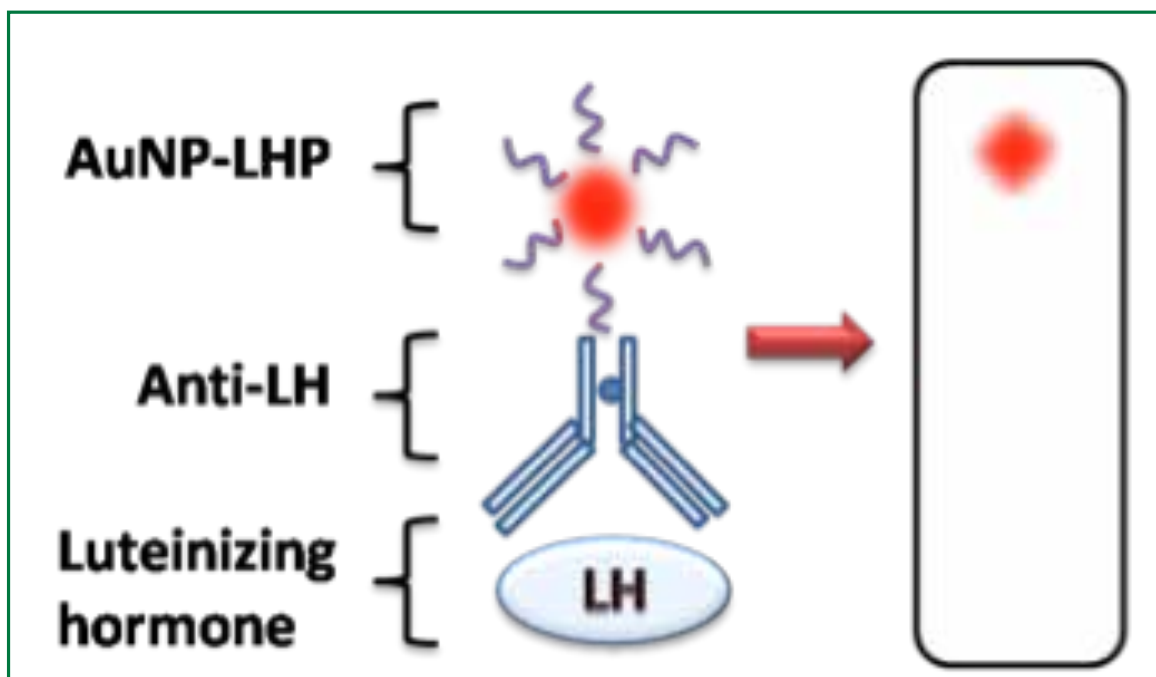
An important determinant to the economics of small ruminant production is the genetic quality of the animals. Males represent 50 percent of the genetics of a flock or herd; therefore, use of high quality males is the most commonly used method to increase genetic quality in the herd/flock. Purchasing high quality males is often cost-prohibitive for small farm family operations, and this limits their ability to compete with larger farms. One alternative to owning an expensive male is to artificially inseminate females using semen from genetically superior males. Purchase of semen is much less expensive than buying high quality rams and bucks. This would theoretically eliminate the need for keeping males in the herd/flock.

A major problem is determining the appropriate time to inseminate. Ewes exhibit very little sexual behavior, making it almost impossible to determine estrus (when a female animal is ready to mate and

able to become pregnant) in this species without the ram. Vasectomized teaser males are often used to determine estrus, but it is expensive to maintain these males. Also, if the producer is not familiar with the history of the ram, and it has a venereal disease, the disease can be transmitted to the females anytime they are mounted and intromission occurs. The devices currently available to detect estrus do not work effectively in goats and sheep in the absence of the male.

If a device could be developed to determine the appropriate time to breed in the absence of a male, this would be highly beneficial and could result in increased use of artificial insemination by small farm family operations.

Since neither ewes nor goats always have overt behavioral or physically identifiable changes that signal the optimum time to breed, a physiological



change must be detected. One of the most common changes that can be measured in the blood that occurs prior to estrus and ovulation is luteinizing hormone (LH). An LH surge occurs prior to ovulation and sets the time for ovulation. In goats synchronized with medroxyprogesterone acetate (MGA), for example, ovulation occurs approximately 26 hours after the LH surge. The main goal of this project is to develop a device that can quantitatively detect real time changes in concentrations of LH. There are very few assays known for detecting LH in the blood of domestic animals. The most sensitive requires radioactive isotopes, which are not feasible for farmers. Another major disadvantage of existing assays is the requirement of large volumes of samples to perform the measurements. There is an absolute need for developing a novel and accurate sensor for detecting LH.

Our long-term goal is to develop a nanotechnology-based sensor to accurately detect luteinizing hormone of sheep. The hypothesis behind the proposed research is that the construct of gold nanoparticles conjugated with biomolecules or antibodies is an excellent sensor and provides a new dimension toward the development of a sensor device for the accurate detection of luteinizing hormone (LH). Our hypothesis is based on the experimental observations from our detailed studies as proof of concept gold nanoparticles (AuNPs), a UV-Visible and Plasmon absorber, is an excellent sensor for detecting biomolecules or antigens in lower than parts-per-billion (ppb) concentration. Our proof of concept studies have established the following results:

- Anti-protein A conjugated AuNPs detect low concentrations of protein A with a high degree of specificity.

- Antibody to LH has high affinity and selectivity toward identifying LH of sheep.
- AuNP conjugated LH-avid peptide, shows high specificity towards recognizing low concentrations of antibody of LH as established using detailed immunoassay experiments.

We have designed and developed a novel LH-peptide sequence and evaluated its affinity towards Anti-LH using ELISA technique. Based on these experimental evidences, the focus of the present proposal is to perform real-time field trials to utilize AuNP-LH-peptide based nanosensor to detect LH in sheep. The specific aims of this research project are designed to evaluate the specificity and detection limits of gold nanoparticles conjugated with LH-peptide against LH of sheep.

Detection of LH using AuNP-LHP activity in samples obtained from farms may be highly useful in deploying these sensors in real-time applications. Nanotechnology-based sensors may possess the potential to identify extremely low concentrations of LH.

The outcome of this project has a direct impact on increasing genetic quality in the herd/flock, economics of production, increased use of artificial insemination by small farm family operations, and a breakthrough in design of nanosensors for accurate detection of biomolecules. This results in both farmers and scientists benefitting from the outcome of this research.

Reducing Arsenic Uptake by Domestic Rice Plants

Dr. John Yang

Human exposure to arsenic causes many severe health problems including various types of cancers. A recent survey indicated that rice grains produced from the South Central United States, such as Missouri and Arkansas, contained elevated arsenic concentrations due to historical application of arsenic-containing pesticides, which is a health threat to rice consumers. This joint research aims to investigate the interactions between arsenic and key soil constituents and then develop management strategies that could lead to effective reduction of arsenic content in rice grains and the occurrence of arsenic-induced rice straighthead disease through integrated laboratory, greenhouse and field studies. The research is designed to address food safety issues under the United States Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA) Priority Area #2, in the discipline area of Environmental Sciences/Management, and to support Strategic Goal #4: Enhance Protection and Safety of the Nation's Agriculture and Food Supply.

The overall goal of this study is to investigate the arsenic interactions with key soil minerals and develop an effective management strategy to reduce arsenic content of rice grains in arsenic-elevated soil through laboratory, greenhouse and field studies, in an effort to improve quality and safety of US-produced rice and to safeguard human health from soil arsenic contamination. Specific objectives are as follows:

- Determine key soil constituents controlling arsenic phyto-availability or uptake by rice plants;
- Evaluate arsenic accumulation and species in grains by domestic rice cultivars;

- Investigate the impact of iron oxides and phosphates on the arsenic solubility and uptake; and
- Develop management strategies to effectively reduce arsenic uptake by rice plants.

Outcomes of this research will help rice growers develop effective management strategies to reduce arsenic content in rice grain and produce high quality, marketable rice grains. This will help safeguard US citizens and consumers from the potential health risk of arsenic-elevated rice products and promote rice-based regional economies.

The following activities have been undertaken to achieve the proposed objectives during the period of 2009-2010:

1) The chemical analyses of the soils and rice-grain samples collected from the field experiment at the Dale Bumpers National Rice Research Center in Arkansas in 2009 were completed. Data indicated that arsenic content in rice grain was cultivar-dependent and influenced by water management. Arsenic solubility was strongly related to formation of iron hydroxides and iron phosphates in soil. Soil wet-dry water management would substantially reduce the arsenic accumulation. The plant tissues collected are currently being analyzed to link the arsenic content to the occurrence of rice straight-head disease and assess the relationship of the arsenic-macro/trace-nutrients (Fe, P, Zn, etc.). The analysis of arsenic speciation in the soils and grains are underway using synchrotron x-ray technique.

2) Laboratory studies of the arsenic absorption/desorption, isotherm and leaching characteristics in soil as a function of dose, solution pH, ionic strength, S:L ratio and time have been performed. The samples are being analyzed. The interactions of



arsenic and speciation with selected soil minerals such as iron (hydr)oxides and iron phosphates are currently being investigated. Data generated from these studies will be used to model the adsorptive behavior and solubility of arsenic and speciation in soil.

Greenhouse pot experiments have been performed to investigate the impacts of elevated soil arsenic (0, 3, 6, 15, 20 ppm) on plant growth and grain weight of three selected rice cultivars and to quantify the cultivar response to soil arsenic. The growth data measured are currently being processed. The soil and grain sample analyses are in progress.

One graduate and two undergraduate students at Lincoln University, one graduate student at University of Missouri (MU), and two undergraduate students at Missouri University of Science and Technology (MST) were hired and trained during the project. As research assistants, the students are responsible for conducting proposed laboratory greenhouse experiments and analyzing the samples under supervision of the principal investigator (PI) or co-PI on the three campuses, respectively.

Based on data generated from the project, there is currently one manuscript that has been submitted to a scientific journal, and it is in peer-review; one oral presentation was made at the 2010 Lincoln University Research Symposium, and one poster presentation was given at the 2010 Annual Conference of the Missouri Academy of Science. Ms. Joy Pyles received the Undergraduate Research

Award for the oral presentation.

Our future efforts in 2010-2011 will focus on analyzing soil and plant samples, performing data analyses, modeling the arsenic solubility and adsorptive behavior in soil ecosystem, and conducting greenhouse experiments to evaluate the effects of phosphate and iron oxide additions on rice growth and arsenic accumulation.

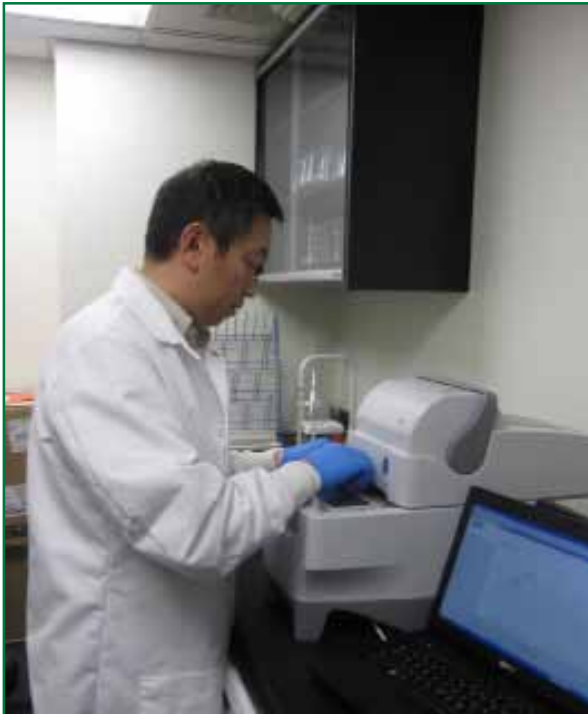
Results from this project will substantially enhance our understanding of the fate, transport, transformation and uptake behavior of arsenic species in the rice-soil ecosystem and provide an effective management strategy to reduce arsenic accumulation of rice grains in arsenic-elevated soils. Outcomes of this project will eventually benefit rice growers and consumers nationwide by improving the quality and safety of rice grains, enhancing the marketability and export of US rice products, strengthening the rice-based regional economy, and reducing the potential health risks associated with arsenic exposure.

Additionally, this research will provide training opportunities for undergraduate and graduate students, help to build LU's education and research capacity, and facilitate multi-institution, multi-disciplinary collaboration on environmental research. The target audience of this research includes US rice growers, rice processing manufacturers, general rice consumers, and environmental professionals, including scientists, engineers, educators, students, administrators and decision makers.



Tracking Agricultural Sources of Fecal Pollution in Water

Dr. Guolu Zheng



Livestock (mainly cattle, swine and poultry) is the major source of fecal pollution in water. Fecal pollution poses a risk to human health as animal feces carry zoonotic (communicable diseases from animals to humans under natural conditions) pathogens. Current fecal pollution monitoring and regulation for water quality is based on the amount of the fecal indicator bacterium *E.coli*, or enterococci, but the numeration cannot identify the sources of fecal pollution, which can hinder the effort to eliminate or mitigate the pollution.

The overall objective of this project is to use the anaerobic fecal bacterium *Faecalibacterium*, as an alternative fecal indicator for the accurate determination of agricultural sources of fecal pollution in water.

This project was started in September 2010. Over 200 fecal samples were collected from livestock farms located in the Columbia and Linn regions of Missouri. The livestock included beef cattle, dairy cattle, swine, chicken, turkey, sheep and horse. Total DNAs were extracted from the fecal samples. Bioinformatics analysis of reported *Faecalibacterium* 16S rDNA sequences was carried out and has identified eight poultry-feces specific and three swine-feces specific DNA sequences within the 16S rDNAs. Based on the newly identified genetic markers, three assays of poultry-feces specific polymerase chain reaction (PCR) have been developed and are under evaluation for their specificity and sensitivity, using the total fecal DNAs. A swine-feces-specific PCR assay is under development.

The resulting poultry- or swine-feces PCR assays may be useful to determine the sources of fecal pollution in the impaired waterways in Missouri and the US.



Soil Management Practices and Greenhouse Gas Emissions from Agricultural Fields, Pasture and Forest

Dr. Nsalambi Nkongolo



The concentration of CO_2 , CH_4 and N_2O (carbon dioxide, methane and nitrous oxide) in the atmosphere is increasing and a good deal of research has been conducted to estimate emissions of these greenhouse gases from soils. Although numerous measurements have been made, emissions from soils still show variability based on a number of controlling factors. The goals of this work on soil management practices are as follows:

- 1) to improve our understanding of the relationship between static and dynamic soil variables and greenhouse gas fluxes in various ecosystems; and
- 2) to develop methods to measure, monitor, quantify and predict greenhouse gas fluxes and soil properties.

Specific objectives of this study are to investigate how soil pore space and thermal properties indices (pore tortuosity factor, relative gas diffusion coefficient and thermal conductivity, diffusivity and resistivity) relate to greenhouse gas fluxes from soils under agricultural fields,

Lincoln University is the sole minority school to be invited to join a consortium of several lead universities to study corn and climate change.



forest and pasture; how pore space indices vary in these soils with different land use types; and how the use of geospatial technologies such as global positioning systems (GPS), geographic information systems (GIS) and geostatics in our sampling strategies improve the estimation of greenhouse gas fluxes, static soil characteristics and dynamic soil properties.

The project has generated new knowledge by identifying other soil properties (soil thermal properties) which act as controlling factors for greenhouse gas emissions from soil in agricultural fields.

Greenhouse gases affect the global climate and, therefore, threaten people in Missouri and the nation; thus, they affect the future of humankind. By providing useful information on soil controlling factors and developing new methodologies for the measurement of these

gases, the project helps the United States to meet its long-term goal of sustaining US agricultural production while maintaining or improving soil and environmental quality in crop, forest and rangelands systems. The successful completion of this project has led Lincoln University to emerge as one of the institutions conducting cutting edge research on global climate change. As a result, Lincoln University is the sole minority school to be invited to join a consortium of several lead universities to study corn and climate change.



Novel 3-D Biosensor for Rapid Detection and Accurate Identification of *E. coli* O157:H7 in Beef

Dr. Majed El-Dweik

Escherichia coli O157:H7 is clearly one of the deadliest food borne pathogenic bacteria. It causes an estimated 73,000 cases of infection and 61 human deaths in the United States each year (Centers for Disease Control and Prevention, 2006). This bacterium has been linked to hemolytic uremic syndrome and hemorrhagic colitis. These illnesses may cause diarrhea, seizure, stroke, kidney failure and even death (Food and Drug Administration, 2008). They are often misdiagnosed, resulting in expensive medical testing before they are correctly diagnosed. In addition, *E. coli* has the potential to cause enormous national and international economical devastation due to medical costs and product recalls, as recently occurred with the recall of tomatoes due to *E. coli* O157:H7 contamination. It can also be found in vegetables, unpasteurized milk, juice and un-chlorinated water. Contamination can have a significant impact on businesses, such as in the beef industry. *E. coli* O157:H7 can be found on most cattle farms and can live in the intestines of healthy cattle; thus, the meat can become contaminated with *E. coli* O157:H7 during slaughter. It is important to note that the infectious dose of *E. coli* O157:H7 is as low as 10 cells (Federal Register, 1990, 1991). Therefore, effective detection techniques are crucial to monitor and control *E. coli* O157:H7 in food products.

Testing for the bacteria requires extensive analysis that has to meet certain challenging criteria. Sensitivity and response time for the analysis are imperative factors related to the usefulness of microbiological testing. An extremely selective detection methodology is also required because low numbers of pathogenic bacteria are often present in a complex biological environment, along with many other nonpathogenic organisms. Traditional methods for the detection of bacteria are not available in the time scale desired in a clinical laboratory. In response to this problem, a number

of instruments have been developed, using various principles of detection, such as flow cytometry polymerase chain reaction, immunomagnetic separations, bioluminescence and mass spectrometry. These methods, however, are still time consuming and expensive.

The proposed project will develop a novel three-dimensional (3-D) interdigitated microelectrode array (IDE)-based impedance biosensor. This biosensor will be capable of rapid detection and for selective, accurate identification of *E. coli* O157:H7. This design is unique in the use of a 3-D IDE because it increases the surface area compared to a single (2-D) IDE sensor. The increased surface area will enhance the sensitivity of impedance detection. Each IDE biosensor consists of 100 pairs of gold electrode “fingers” with a length of 0.5 millimeters. The IDE array will be designed with spaces between the interdigitated electrodes nearly the size of the bacteria in order to detect a single or a few bacteria cells.

Research Objectives

- 1) Designing and fabricating Microelectromechanical Systems (MEMS)-based impedance biosensor system.** The device will consist of two arrays of 3-D IDEs and a fluidic channel with an inlet and outlet. Each IDE array will consist of 100 pairs of gold electrode fingers fabricated using surface micromachining and photoresist sacrificial layer.
- 2) Immobilizing the antibody using the Self-Assembled Multilayer (SAM) process.** We will use the SAM process to immobilize the antibodies onto the IDE. This stage will provide the binding between bacteria and antibodies due to the high affinity between them.
- 3) Testing the device using impedance measurements.** We will analyze the biosensor for the detection and selective identification of *E. coli*

| Design | Electrode Length(um) | Electrode Width(um) | Spacing between two Electrodes(um) |
|--------|----------------------|---------------------|------------------------------------|
| 1 | 1500 | 10 | 5 |
| 2 | 1500 | 15 | 5 |
| 3 | 1500 | 8 | 4 |
| 4 | 1500 | 6 | 4 |
| 5 | 1500 | 4 | 2 |
| 6 | 1500 | 3 | 2 |

Electrode dimension of six different designs

O157:H7 in beef when used in conjunction with the immobilized antibodies, and determine the magnitude and phase of the impedance of the bacteria effect alone. The effect of frequency on impedance measurements will be monitored and analyzed.

Accomplishment of Research Objectives

Biosensor Design The proposed *E-Coli O157:H7* biosensor will be designed with a 3-D high density cylindrical IDE array. The IDE surface is modified to immobilize antibodies and is used as the sensing surface to detect bacteria concentration in solution (figure 1). The design is unique in the use of a 3-D IDE with a micro channel to increase the surface-to-volume ratio and decrease the sample volume, resulting in a rapid and high sensitivity impedance biosensor.

The IDE array will be designed to detect a single or a few bacteria cells. Each IDE biosensor consists of 100 pairs of gold electrode fingers. The dimensions and spacing between electrodes will be close to the bacteria size, with the exact dimensions determined by using simulation tools. Simulation of the electric field will be performed on several designs in order to determine the electric field strength near the surface, and to optimize the width, length and

spacing between the electrodes.

The biosensor will be exposed to bacteria via a flow channel. During the bacterial suspension flow, the antibodies are immobilized on the microelectrodes using the SAM process. When bacteria bind to antibodies, only a region of 2-4 micrometers (μm) above the sensor surface is modified. The impedance measurement results will change as the concentration of bacteria bound to the sensor surface changes. The advantages of using the 3-D IDE impedance system include a reduction in the sample volume, a more rapid detection time (within several minutes), low resistance and a high signal-to-noise ratio.

Biosensor Fabrication The biosensors will be built through a series of surface micromachining processes, including photolithography, metal sputtering, polydimethylsiloxane (PDMS) processes, and wet and dry etching atop a glass substrate. The device will consist of microelectrode arrays, micro channel, and fluidic inlet and outlet, and will be fabricated using the following sequence:

- 1) A thin layer of titanium (Ti) and gold (Au) will be sputter-deposited and patterned to form the bottom of the IDE array and bonding pads.
- 2) A photo resist sacrificial layer with a thickness of 50-100 μm will be spin coated, patterned and cured to form the micro channel.
- 3) Two layers of Au and Ti will then be sputter deposited to serve as the top side of the interdigitated electrode array. The nominal thickness of Au and Ti are 500 nm and 100 nm, respectively. Initially, the titanium is patterned to form the interdigitated electrode array. The photoresist used to pattern Ti will be removed using acetone and isopropanol. The gold between the interdigitated electrode array will be



Here is the fabricated biosensor. There are tygon tubes connected to the inlet and outlet.

removed using Ti as the etch stop mask.

4) A layer of SiO_2 ($0.5 \mu\text{m}$) will be deposited using RF-sputtering and patterned to form the top cover of the channel with openings for the inlet and outlet.

5) A fluidic connector will be connected to the inlet and outlet, using adhesive PDMS, a type of silicone.

6) A thick layer of PDMS will be poured atop the device and cured in order to form a reliable device.

7) The sacrificial photoresist layer in the micro channel will be removed by immersing the devices in acetone for one hour.

Impacts of Research (economic, social, environmental, human health, etc.)

Our research will provide accurate and real-time measurements for small samples of *E.coli O157:H7*. FSIS as well as meat processors and handlers will be able to identify the contamination and quantify it. This valuable information will be used to determine elimination of the contaminated meat and save the market from recall, which can be very costly.

Embryonic and Fetal Loss in Goats: Characterization of Amount, Timing and Factors Associated with Losses

Dr. A. K. Wurst and
Dr. Charlotte Clifford-Rathert



Embryonic and fetal mortality are large sources of economic loss in the livestock industry. Although average ovulation rates are sufficient, a significant economic

loss results from a large percentage of oocytes not resulting in live offspring. Recent research in ewes has shown that embryonic and fetal losses occur relatively evenly throughout pregnancy. Although current estimates of embryonic and fetal wastage in goats are similar to those found in early sheep studies, detailed real-time evaluations of pregnancy loss have not been conducted.

The objective of this study is to determine if embryonic and fetal loss patterns and rates are similar among small ruminant species and to determine if loss can be associated with a dam, embryo/fetus or buck influence. Bred does in multiple herds were scanned on approximate days 25, 40, 60 and 110 post-breeding (Day 0 = buck introduction) by trans-rectal or trans-abdominal ultrasonography. At kidding, owners/managers of the respective herds recorded the doe number, kidding date, and number of kids born, along with comments on any abnormalities or difficulties with the pregnancy or birth, and returned results to the authors for analyses.

For the 2009 breeding season, there was a total of 332 does in nine herds with records through kidding. Herds were primarily composed of Boer and Boer-crosses, with one herd including French Alpine, Angora and Saanan does. Initial pregnancy rates of does within herds were good and averaged 89 percent at first scanning.



A total of 24.6 percent of does pregnant at first scanning had some pregnancy loss (either partial or total) through kidding with 12.3 percent showing total pregnancy loss and 12.3 percent showing partial loss of embryos or fetuses. However, within-herd losses varied considerably with one herd having 37 percent of pregnant does showing loss and one herd having no loss. Interestingly, 97 percent losses occurred past day 60 in the does studied. The 2010 breeding season is currently still in progress but results include 168 does in five herds through day 60 of pregnancy.

A total of 8.9 percent of does pregnant at first scanning have had some pregnancy loss by day 60 of pregnancy. Of these does, 7.5 percent had partial pregnancy loss and 1.4 percent had total pregnancy loss. These results are similar to those found in the previous year in that loss rates were low through the first 60 days of pregnancy and were highest after day 110 of pregnancy. These results suggest that embryonic and fetal wastage in goats may be a significant problem for some herds. Further, preliminary data suggests that these losses occur at a different rate than those found in sheep, and that losses seem to primarily occur relatively late in pregnancy. If results of the 2010 season continue to be similar to the 2009 breeding season, they would indicate that embryonic and fetal wastage in goats is clearly a significant factor in reproductive management.

Although economic repercussions have not been assessed at this time in goats, economic reports on sheep production indicate that

pregnancy losses result in about one-third of potential profit lost by the time of lambing in sheep. This number could be significantly larger in goats, depending on the type and use of the herd in question.

Aquaculture Nutrition Research Initiative in Missouri: Developing a Least-Cost Diet to Produce Bluegill Fingerlings

Dr. Thomas R. Omara-Alwala



There are no formulated diets for the production of bluegill (*Lepomis macrochirus*) fingerlings (a small fish up to one year of age). Bluegill has been identified by the North Central Regional Aquaculture Center (NCRAC) as the potential aquaculture taxa for the North Central Region (NCR). The overall objective of the project was to develop physically stable, nutritionally balanced and palatable least-cost diets containing different percentages of distillers' dried grains with solubles

(DDGS) to produce bluegill fingerlings in recirculating aquaculture systems (RAS).

Selected commercial feeds in the US market were evaluated for their efficacy in the production of bluegill post-larvae in a RAS at the Lincoln University Aquaculture Nutrition Research Laboratory. The best diet was used afterwards for the determination of the weaning period of bluegill post-larvae in the RAS. Physically stable, nutritionally balanced and palatable least-cost diets containing different percentages of DDGS were developed. The least-cost diets were used for the determination of the growth performance characteristics of bluegill fingerlings.

The results demonstrated that a least-cost diet containing DDGS could be used effectively for the production of bluegill in an RAS without affecting its growth characteristics. The information could be valuable to the aquaculture farmers by potentially reducing the cost of aquaculture feeds. The use of DDGS, a common corn byproduct, could also economically benefit the grain farmers of the region.



Phenotypic Plasticity in Mosquito Populations: Potential for Disease Transmission

Dr. Jennifer Benne



The vector ecology research laboratory investigates the larval developmental stages of mosquito species as influenced by environmental factors. Global temperature changes can affect the developmental patterns and adult fitness of multiple mosquito species. The ability to predict the relationship between degree days, adult size and fitness is essential to mosquito monitoring and abatement efforts. This project also focuses on examining a potential relationship of livestock species and mosquito community diversity.

This year the vector ecology research group had a second successful trapping season monitoring adult mosquito populations around various livestock facilities. This study compared the species richness and diversity found at farms housing specific types of livestock including poultry, horses, cows, pigs or goats. In this trapping season, more than 3,000 adult mosquitoes were collected and identi-

fied to species. In addition, a student research project investigating effective trapping measures was presented at the 2010 Missouri Academy of Science meeting. Two additional student research projects examining environmental influences such as the dimensions of breeding containers, population densities and cohort mortality influences on larval development were examined using environmental chambers. These studies were possible as laboratory colonies of *Aedes triseriatus*, *Aedes albopictus* and *Aedes aegypti* have now been established at Lincoln University. Abstracts from three undergraduate and one graduate student have been accepted by the Entomological Society of America for presentation at the 2010 national

meeting in December.

Understanding larval mosquito development time and subsequent size of adult females are significant factors influencing their ability to accept and transmit a variety of human and animal viruses. The ability of regions to accurately predict and minimize expenses associated with mosquito abatement are key to a successful mosquito control program.

With the changing global environment, the presence of invading mosquito species as well as the movement of existing mosquito species may impact the endemic regions of certain mosquito-borne diseases.

Marketable Yield of Kale (*Brassica oleracea* 'Vates') in Ebb and Flow Hydroponic Culture

Dr. Jonathan Egilla



Kale (*Brassica oleracea* 'Vates') is one of the important leafy green vegetables in the United States, but most of the home garden and commercial production occurs in the southern states where it is more popular. Similar to collards, kale is grown for its abundant green foliage (figure 1). The leaves are usually consumed as a cooked vegetable or as an ingredient in other foods. Kale is a winter-hardy biennial. It is desirable as a garden vegetable because of its relative tolerance to both lower and higher temperatures than cabbage.

Experiments were conducted to determine the marketable yield of kale leaves in flood-and-drain/ebb and flow (eb&f) hydroponic culture experiments under controlled environment greenhouse conditions during spring/summer 2010. Two-to-three-week-old seedlings established in rockwool were potted in 6-inch plastic pots containing a commercial calcined clay root substrate (Turface®) and then transferred into an eb&f hydroponic system. Plants were grown with a soluble commercial fertilizer (Peters Excel-CAL-MAG; 15N-2.2P-12.5K [CAMG]) at two nutrient solution concentrations prepared to supply nitrogen (N) at 150 milligrams per liter (mg L^{-1} ; C_1) and 200 mg L^{-1} (C_2).

Figure 1. Dimensions of a Mini Gro-Table (A & B) and kale seedlings after two (A) and eight (B & C) weeks in ebb and flow hydroponic culture. Older, fully-expanded leaves at the base of the plant were removed during each harvest cycle.

Leaves from replicate plants were harvested for growth and yield determination 42, 59 and 88 days after transfer (DAT) into eb&f culture. Differences between C_1 and C_2 in leaf yield (leaf count, leaf fresh weight [g/plant], leaf width and leaf length [cm/plant]) varied at each of the three harvest dates. With the exception of leaf fresh weight (42- and 88-DAT) and leaf width (42-DAT), there were no significant differences in leaf yield between the two fertilizer concentrations. These observations suggest that with calcined clay substrate, satisfactory yield can be obtained from kale, when CAMG is used at 150 mg N L^{-1} .

These results have positive implications for the N nutrition of kale in eb&f hydroponic production, since the goal of N management of vegetable crops is to obtain optimum yield from the least amount of N supply. However, for profitable commercial production the extra 50 to 100 g increase in leaf fresh weight might justify the higher nutrient solution concentration at 200 mg N L^{-1} .

Here are the positive impacts of these findings on the agricultural audience:

1) It provides information to the home gardener and small-scale vegetable grower about an easier alternative method of producing abundant quantities of a leaf vegetable crop (kale) in limited space. The Mini Gro-Table™

eb&f hydroponic system can be used for backyard gardening of many leaf vegetable and herb crops.

2) With eb&f hydroponics, the added plant nutrients are recirculated within each unit until depleted; therefore, the tendency for environmental contamination with fertilizers is minimized.

3) The ease with which vegetable crops can be produced with this hydroponic system will encourage many aspiring gardeners to grow more crops for local consumption. Vegetable growers can adopt the techniques described in their small-scale commercial crop production facilities profitably by coupling several Mini Gro-Table units.

Effect of Surfactants on Soil Microbial Activity

Dr. Frieda Eivazi



Soil is the direct recipient of surfactants; however, little is known about the behavior and fate of these chemicals on the soil ecosystem. Since a considerable quantity of surfactants is added to soil, there is a need for research investigating the surfactant-soil interactions. The overall objective of this project was to determine changes in soil microbial consortia as affected by different surfactants and to determine the effect of surfactants on plant nutrient uptake.

Greenhouse experiments were conducted during spring 2010. Soils samples were collected from Lincoln University's George Washington Carver Farm and the University of Missouri (MU) Bradford Research and Extension Center. The samples were placed in pots, which were fertilized and limed in accordance with soil recommendations from the soil test results. In each pot, six field corn seeds were planted and then thinned to two plants.

Surfactants, Activator 90 (non-ionic), Agri-dex (non-ionic), and Thrust (anti-foam agent) and Herbicides, Gly-4 Plus (pre-emergent), Atrazine (post emergent), and Basagran (post emergent) were applied. All chemicals were applied based on label recommendations. Treatments were added as surfactants only, herbicide

only, and surfactant-plus-herbicide combination arranged in complete randomized block design on greenhouse benches.

After seven weeks, the experiment was terminated, and plants and soil samples were collected, stored and processed for elemental analyses. Foliage samples were digested using the microwave digestion method with Nitric Acid-Perchloric Acid mixture. Total elemental analyses of the samples were determined using an Inductively Coupled Plasma (ICP) Emission Spectrophotometer. Soil samples were analyzed using Polymerase Chain Reaction (PCR) and Denaturing Gradient Gel Electrophoresis (DGGE) technique to determine changes in community structure with respect to different treatments.

The results indicated that the soil type may influence the effect of the surfactants on nutrient uptake. Soil with a high clay content caused more sorption of surfactants and herbicides to active sites. The carbon to nitrogen (C/N) ratio and microbial DNA concentration differed with treatments of surfactants and herbicides. The diversity of bacterial population was affected by the application rates of surfactants and the presence of herbicides.

It was concluded that in assessing effects of herbicides on plant nutrient uptake and microbial activity, one should consider both the active ingredient and the formulation additives, including surfactants, before application.



Evaluation of Production of Bluegill and Sunfish Hybrids

Mr. Charles Hicks

Missouri has over 300,000 rural ponds that could be used for sunfish production for markets currently existing in the North Central region. Viable commercial production methods can be developed for these farmers to supplement the family or farm income. Consumers are increasingly seeking locally produced food. This study demonstrates that rearing food-sized fish can be accomplished in farm and production ponds to provide to the local community. Making nutritious fresh fish available, especially to the low-resource rural communities, will have social and economic benefits.

Previous evaluations concluded out-of-season spawning is not practical for commercial production, and methods for spawning induction in sunfish are not well developed. Little research has been conducted to evaluate, on a commercial scale, sunfish hybrids.

The overall objectives were as follows:

- 1) to compare the growth characteristics of bluegill sunfish with selected hybrids, and also of triploids, in indoor water recycled and earthen pond systems;

- 2) to validate methods with a field trial; and

- 3) to evaluate filet yield.

Young-of-the-Year (YOY) of the following crosses were reared in 0.1 ha ponds for one summer (0+) and evaluated for growth in indoor tanks for five months (where ♀ = female and ♂ = male) : redear ♀ X bluegill ♂, green sunfish ♀ X bluegill ♂; and warmouth ♀ X bluegill ♂; and pure bluegill.

Equal numbers of each hybrid cross and bluegill were then stocked into four 0.1 hectare ponds. Ponds were harvested in six months and growth was evaluated (L/W).

Cage culture was evaluated as field trials at three Missouri farms. Results were positive, indicating that with only a minimum of training, farmers can produce acceptable results. More training and outreach is needed.



Triploid production resulted in fertilized eggs that did not survive. Bluegill, redear, green sunfish and warmouth hybrids can be produced by pond spawning with appropriate sex combinations. Tank trials indicate indoor rearing was successful. Bluegill were longer and heavier than the other species or hybrids. Pond trials had similar results with the redear hybrid heaviest, and the warmouth smallest of all.

This study concludes sunfish hybrids and bluegill are conducive for commercial production in Missouri. Seventy-five percent of bluegill were above-market weight with acceptable filet size. Final weights indicate all the crosses, excepting warmouth, produced market-size fish. This study demonstrates applicable methods, easily adapted by Missouri farmers, to supplement the family income (especially low-resource farmers) and provide nutritious food locally, contributing to the local social and economic status. The fish can be produced for direct consumption or local sales. Presentations, workshops, meetings, personal contacts and field days resulted in over 1,000 direct contacts and have been well received by the stakeholders because several farmers have adopted these methods. This study demonstrates that fish farmers and rural pond owners can rear bluegill and a combination of their hybrids to supplement their income.

Further studies are needed on triploid production, spawning induction and use of steroidal hormones. Once these techniques are developed for sunfish, it could dramatically improve the livelihood of many rural low-resource Missouri farmers. The long-term economic benefits are great.

Effects of Nutrients, Antibiotics and Pathogens from Cattle and Swine Wastes on Water Quality: A Case Study of Two Sites in Central Missouri

Dr. Abua Ikem



The central Missouri region is one of several areas in the United States having confined animal feeding operations (CAFOs) under various animal units' classifications. Water quality of streams near CAFOs may deteriorate due to inputs of *Escherichia coli*, nitrogen, phosphorus and antibiotic drugs from animal waste. Water quality assessments and prediction of stream health allows for development of risk assessment models necessary in arriving at best management practices (BMPs) for stream quality improvement and protection.

The following are objectives of this study:

- 1) to identify water quality variables in CAFO lagoon and wastewater treatment plant (WWTP) runoffs that posed the most threat to Gans Creek and the relative contribution of each water quality variable;
- 2) to observe seasonal and annual patterns in water quality and any influence of CAFO lagoon and WWTP runoffs on stream hydrochemistry;
- 3) to evaluate phosphorus distribution and speciation in sediment and water; and
- 4) to investigate the presence of pharmaceuticals and other emerging chemicals in stream and effluent samples.

This report provided initial baseline data for the beef nutrition research program of the University of Missouri (MU), as well as for policy makers and water resource managers desirous of achieving nutrient reduction goals for the Gans Creek receiving stream.

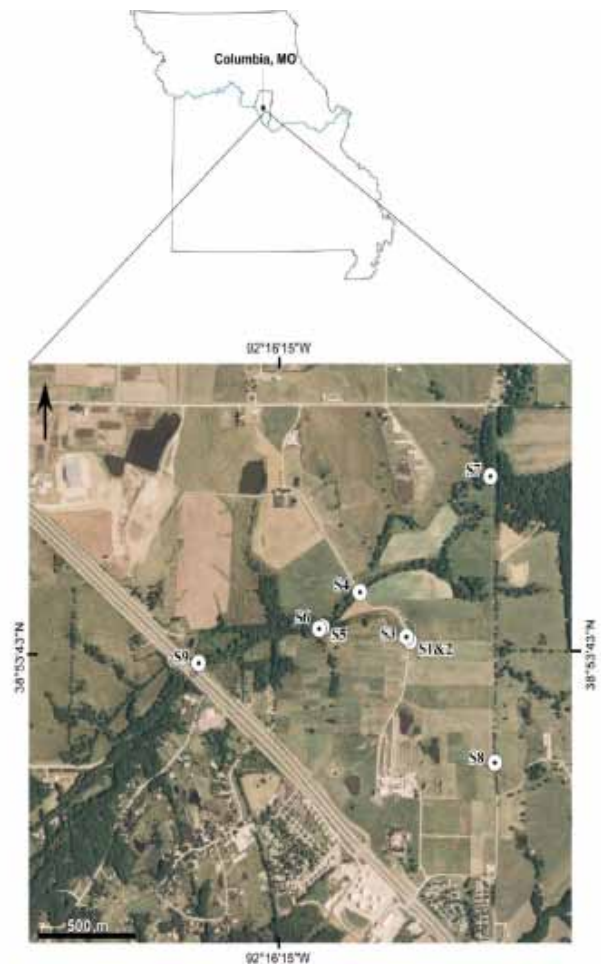
Objectives 1 and 2 were investigated from May 2009 to April 2011 for monthly and seasonal physicochemical characteristics of upstream, midstream, downstream, CAFO lagoon and WWTP samples. Results from the nutrient study suggested that the two point sources contributed to increased ammonia–nitrogen downstream of Gans Creek. Calculated enrichment values for both CAFO lagoon and WWTP wastewaters relative to downstream sample (Gans3) revealed that the WWTP was the major contributor of ammonia–nitrogen to Gans Creek.

Cluster analysis of data collected revealed differences between upstream and downstream samples



due to the influence of dissolved materials from lagoon and WWTP runoffs on stream quality. The influence of the two runoffs was more apparent during the spring and summer periods, and diffuse pollution was significant during the winter period. Boron, a known marker for household wastewater, was found in highest concentration in the WWTP runoff.

Overall, a significant reduction in nitrogen levels in WWTP discharged will lead to improved stream quality. Nutrient (N, P) reduction strategies have been implemented by the beef farm manager and a follow-up water quality assessment is underway. The residential wastewater treatment plant and sewage collection system should be evaluated for effectiveness, and pollution reduction strategies should be implemented. Public awareness can also help to reduce the amount of household chemicals and chemical products dumped into the sewerage system. We are conducting experiments on objective 3, and plans are in place to execute objective 4 from summer 2011 to spring 2012.



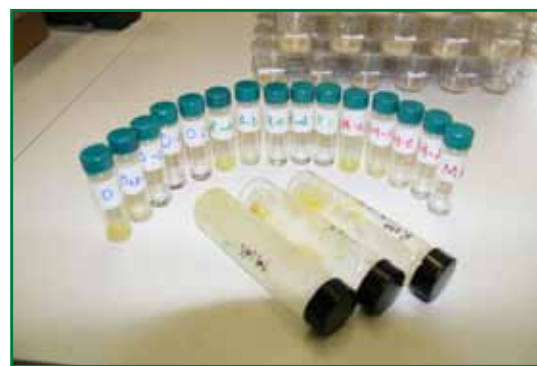
Investigation of Insect Resistance and Insect Control Potential of Scented Geraniums

Dr. Hwei-Yiing Johnson

Scented geraniums have been known for versatile uses including culinary, medicine, essential oil production, repelling mosquitoes, and recently, heavy metal hyper-accumulative capability. Lincoln University has maintained a collection of scented geraniums (*Pelargonium* sp), varying in insect resistance, morphological characteristics and aroma to support the study insect control potential and insect resistance. Most of the scented geraniums in the LU collection exhibit strong insect resistance and remain free of insects while other plants in the same greenhouse are prone to insect infestation and damages. A major concern of this study is the similarity between plants due to the unavailability of scientific names which results from a long history of hybridization with untraceable breeding records. Therefore, it is crucial to clearly identify and distinguish scented geraniums that are used for this study.

Scented geraniums were first categorized into groups or chemo-types based on the results of scent analysis. Plant foliage was sampled and directly subjected to volatile chemical analysis, using the Solid Phase Micro-Extraction (SPME) technique coupled with gas chromatography and mass spectrometry. DNA fingerprinting of scented geraniums with the use of Target Region Amplification Polymorphism

(TRAP) successfully distinguished scented geraniums and showed the genetic similarity among plants. Grouping of scented geraniums based on DNA fingerprinting was consistent with the grouping results based on the morphological characteristics and volatile chemical analysis. Scented geraniums representing major chemotypes were selected. Plants were mass propagated, cultivated and extracted for essential oils. Three methods, including steam distillation, solvent extraction and super critical CO₂ extraction, were used for extraction. The super critical CO₂ extraction yielded the best oils in quality and quantity, and required the least processing time. A bioassay named “feed overlay bioassay” was performed to determine the biological activity of the oils against neonate cabbage loopers (*Trichoplusia ni*), an undesirable insect. The results showed concentrations 0.01- 0.1 g crude extract/ml of essential oils exhibited insecticidal activity. As compared to the greenhouse and field tests, a smaller amount of oil produced by live scented geranium plants and/or by crushing a few fresh leaves could deter insects and adversely affect insect behav-



The left image shows color differences pre- and post-extraction. The right image shows the essential oils extracted and dilutions made for bioassays. The vials in the background are used for insect bioassays.

ior. The differences in results may be caused by low yield and possible loss of active ingredients in oils through volatilization and degradation during extraction and bioassay. A more vigorous and sensitive bioassay is critically needed to effectively test olfactory sensitivity in insect response to scented geraniums.

The demand for field grown scented geraniums could increase as more useful characteristics of scented geraniums involving pharmaceutical and environmental applications are identified. An additional study was carried out to test the effectiveness of compost application on scented geranium growth in the greenhouse and field. Results suggested that amending compost at 10 percent (a 9:1 ratio of soil and compost v/v) was sufficient to support scented geranium growth. The outcomes and impacts of this study can be summarized as follows:

1) The integrated approach of using morphological characteristics, volatile chemical profiles, and DNA fingerprinting for distinguishing scented geraniums, effectively distinguish the identity and relationships among plants in the scented geranium collection. The same approach can be applied to other plant collections with challenging genetic identity and genetic relationships.

2) TRAP technique was effective in DNA fingerprinting and revealing genetic similarity among scented geraniums in this study. This technique has strong potential for application and for studying the genetic diversity of other crops due to its high throughput, resolution, relatively low cost and short process time.

3) Super critical CO₂ extraction yielded the best oil, in quality and quantity, and required the least processing time. This method was



The left image shows the device used for super critical CO₂ extraction at the National Center for Agricultural Utilization Research Center in Peoria, Illinois, as a collaborative effort with Lincoln University. The right image shows a cylinder containing plant materials inside the extraction chamber.

preferred for essential oil extraction due to efficiency.

4) A sensitive and effective bioassay is critical in testing olfactory sensitivity on insects' response to scented geraniums. A test requiring the least amount of time is desired due to possible loss of active ingredients through evaporation and degradation during material processing. The development of an effective and sensitive bioassay is critical in the attempt to disclose the resistant mechanisms of scented geraniums and other aromatic plants to undesirable insects.

5) A study of cultivating scented geraniums in the greenhouse and field with compost amendments suggesting amending compost at 10 percent application rate was sufficient to support scented geranium growth. The finding could help develop a field production guide for cultivating scented geraniums.

Production of Sweet Potato and Watermelon in Central Missouri Using Alternative Management Practices

Dr. Rufus Jones (posthumously published)

Dr. Wesseh Wollo



The overall goal of the project/study is to develop cultural and management systems to improve the adaptation and quality of sweet potato (*Ipomoea batatas*) and watermelon (*Citrullus lanatus*) in Central Missouri and to determine the economic implications of these practices.

Following are the specific objectives:

- 1) to evaluate the performance and quality of selected commercial sweet potato varieties when treated with different rates of nitrogen fertilizer and the application of irrigation water at different stages of growth;
- 2) to determine the economic potential of culture and management practices used in the production of sweet potato in Central Missouri;
- 3) to evaluate the performance of watermelon grown under row covers in the fields of Central Missouri; and
- 4) to evaluate the economic potential of growing watermelon under row covers in the fields of Central Missouri.

Field plots were established at Lincoln University's George Washington Carver Farm in Jefferson City, Missouri, to investigate the effects of soil-applied nitrogen fertilizer and irrigation on the growth, development and quality of four varieties of sweet potato; and to evaluate the performance of two watermelon cultivars under two types of row-cover. Field samples of the sweet potato were collected every 30 days up until 120 days of growth. This report summarizes results based on 120 days of growth.

Increasing the rate of soil applied nitrogen (N) significantly decreased the yield of number one-sized roots (grade) and significantly increased the fresh vine weight (top weight) of the four sweet potato varieties. Increasing the rate of soil applied N from zero pounds per acre to 90 pounds per acre significantly increased the percent nitrogen in the root and leaf tissues, but did not increase the average marketable root yield. In 2008, irrigation did not increase the yield of the number-one-sized roots. The yield of jumbo-sized roots and total marketable root yield (yield of culls plus the yield of jumbos plus the yield of the number ones) were significantly increased by irrigation during the first 30 days of plant growth. The variety Georgia Jet had significantly higher yields of number one and jumbo-sized roots and marketable root yields than the Centennial, Bunch and Beauregard varieties.

Two watermelon cultivars (Black Diamond and Crimson Sweet) were direct-seeded on raised beds under two different row-covers (slitted plastic row-cover and 50 non-woven polypropylene fabric row-cover) and on traditional direct-seeded raised bed

in three replications. Germination data were recorded up until the removal of the row covers. At harvest, the watermelons were counted and weighed individually. The 50 non-woven polypropylene fabric row-cover significantly increased the number of watermelons produced. Neither row-cover type significantly increased the total watermelon yield. The number of watermelons produced, the total yield and the average yield produced per watermelon did not vary significantly between the two varieties. The variety Black Diamond had a significantly higher germination rate than that of Crimson Sweet. Significantly fewer watermelons were harvested during the earliest harvest date rather than the latest date; however, the average weight per watermelon did not vary between harvest dates.

St. Louis and Kansas City offer good market opportunities for sweet potato producers in Missouri. With improved management practices, it is possible for Missouri farmers to increase their income using high quality sweet potatoes and watermelons. Selecting a superior cultivar of sweet potato and/or watermelon for local growing conditions could have positive short-term impacts on producer economic returns. The return over costs was positive for irrigated sweet potatoes in the 2008 study. This study will have potential implications for promoting improved diets and health in the future.



Research and Development Program for Micro-algae Cultivation, Oil Extraction and Conversion to Biodiesel

Dr. Keesoo Lee



Overall goals of this multidisciplinary (physiology, microbiology, chemistry and engineering), multi-institutional (Lincoln University, Missouri University of Science and Technology Missouri electric power cooperatives and the United States Department of Agriculture-Agricultural Research Service Laboratory) joint research and educational project are as follows:

1) to find solutions to the difficulties encountered in the research and development of microalgal biomass production and conversion to biofuels and other biomaterials; and

2) to train students to integrate knowledge across disciplines through experiential learning opportunities.



Microalgae were isolated from Missouri and surrounding states to find strains that are resistant to invasion and adapt well to local environments have been evaluated for mass cultivation and conversion. A pilot open-pond cultivation system that utilizes flue gas CO_2 (carbon dioxide) from a coal-fired power plant has been constructed and used for the proposed research to develop microalgae-based bioremediation and biofuel technologies. The research has been specifically focused on the selection of algal strains suitable for the region and the improvement of technologies involving harvesting/dewatering processes, conversion to biodiesel and bioethanol, and examination of the residual algal biomass as a bio-fertilizer. The ultimate goal of the project is





to generate high-value/high quality bio-energy/fuel products from sustainable sources and benefit Midwestern farmers.

The bioenergy research laboratory at Lincoln University has been collaborating with scientists from Missouri Science and Technology University and the Missouri regional electricity cooperatives (Associated Electric and Central Electric Power co-operatives) to study the feasibility of using flue gas CO_2 for algae cultivation. These developments have provided research-based experiential learning opportunities to numerous students at both universities.

It was found that the native consortium of *Scenedesmus*, *Eudorina* and *Ankistrodesmus* can tolerate flue gas concentrations ranging 1-4 percent CO_2 and sustain dry algal biomass productivity as high as 19 g/m²/day. The species population change with respect to the monthly local environmental variation was observed. From the compositional and toxicological

analyses of the harvested biomass, it was concluded that the selected consortium of micro-algae biomass can be sustainably produced at pilot scale level, using the flue gas CO_2 directly from the coal-fired power plant.



Natural Recovery Of An Abandoned Limestone Quarry: Heterogeneity in Soil Characteristics and Plant Community

Dr. Kirsten Stephan

Rapid economic development and the growth of urban areas have increased the need for limestone which, in turn, created many abandoned quarrying sites in rural and urban areas. While the latter might represent a challenge to urban managers due to their visual impact, safety concerns, erosion and high cost of re-vegetation, abandoned quarries might also represent an opportunity for the establishment of diverse natural vegetation communities. Abandoned quarries have distinct features such as a quarry floor and top, high walls, spoil mounds, and ponds which potentially give rise to distinct microhabitats with unique plant communities.

The objectives of this study were as follows:

- 1) to quantify the heterogeneity in vegetation composition, soil physical, chemical and biological parameters, and microclimate in an abandoned limestone quarry; and

- 2) to find correlations between soil parameters, vegetation composition and microclimate that might be used to improve management of abandoned quarries.

The study was implemented during the summer and fall of 2010. The study sites were a limestone quarry abandoned 70 years ago (referred to as LU quarry), a forested area that was never quarried (referred to as LU forest) and not otherwise disturbed for the last 100 years, and a recently abandoned quarry (referred to as 54 South quarry) in Jefferson City, Missouri. Eight 3 x 20 m plots have been established at the LU quarry site. Plots were placed on geo-morphologically distinct features such as quarry top near cliff edge, quarry floor near shaded high wall, riparian area near quarry pond, etc. At the LU forest and 54 South quarry, only one plot was established, respectively. These two sites represent potential bookends of conditions in the natural



vegetation succession in quarries. The following data were collected from each plot:

- 1) vegetation composition and species cover (in 20 1 x 1 m quadrants per plot);

- 2) soil samples for analysis of physical (bulk density and particle size distribution), chemical (macro and micronutrients), and biological (microbial activity) parameters (in 20 1x1m quadrats/plot); and

- 3) micro-climate (radiation temperature and relative humidity at 1 m above ground; soil moisture, temperature and electrical conductivity at 5 cm below soil surface) using one climate station per plot.

Within the LU quarry, the proportions of forbs, legumes, graminoids and woody plants present in the herb layer (< 1m in height), as well as species richness, varied significantly between the eight study plots. The relative cover varied between 1 and 12 percent, 0 and 35 percent, 0 and 44 percent, and 6 and 99 percent for the respective plant functional types. Average species richness ranged from

6 to 13 among the plots. Values for pH and bulk density within the top 5 cm from the soil surface ranged from 6.0-7.8 and 1.0-1.6 g cm⁻³, respectively. When contrasting micro-climate in October, the divergence between plots in a) maximum daily average air temperature was 4°C, b) maximum daily average soil temperature was 6°C, and c) average volumetric water content was 24 percent. Our preliminary data suggests that heterogeneity in the LU quarry is significantly greater than in the recently abandoned quarry, but also than in the supposed climax community (LU forest). Further, more

detailed analyses are pending.

Knowledge on the links between microhabitat conditions and the success of certain species or plant groups might be used in accelerating re-vegetation of abandoned limestone quarries. Additionally, the presence of distinct microhabitats could be exploited for conservation and educational purposes via the establishment of diverse native plant communities containing species with conservation concern.



Parasite Control for Small Ruminants

Dr. Helen A. Swartz, Professor/State Sheep, Goat and Small Livestock Specialist

Gastrointestinal parasites, especially *Haemonchus contortus* (barberpole worm), are a serious economic restriction affecting the sheep and goat industry in the United States. Traditionally, gastrointestinal parasites have been controlled through commercial anthelmintics. However, recent concerns about the development of anthelmintic resistance in parasite populations have been reported. One solution to this problem may be to use *Artemisia absinthium* (wormwood) as a natural anthelmintic. Our objective was to determine if wormwood would alter performance and parasite loads in Katahdin ewes and Boer does while grazing for 71 days during the summer. Katahdin ewes ($n = 144$; 145 ± 1.8 average body weight) and Boer does ($n = 151$; 114 ± 3.0 average body weight) were stratified by body weight and age and then allocated randomly to 15 groups within species representing three treatments: (1) control; (2) wormwood (5.5 g/hd/d); and (3) synthetic anthelmintics (4.5 mL/2.2 lb body weight).

At the end of the grazing period, Katahdin ewes offered wormwood gained on average six pounds more than those offered synthetic anthelmintics, but fecal egg counts (FEC), packed cell volume (PCV) and FAMACHA® (a system to evaluate anemia in goats and sheep scores) did not differ across treatments. Whereas, Boer does offered wormwood and synthetic anthelmintics gained 12 pounds more on average than control does. Ending FEC were greater from control does (846 eggs/g) versus does offered either wormwood or synthetic anthelmintics (491 eggs/g average). Ending PCV was greater from does offered synthetic anthelmintics (30 percent) versus does offered wormwood (28 percent), but control does were lower (27 percent) than the other two treatments.

Therefore, offering wormwood may improve body weight gain in both Katahdin ewes and Boer does, but may only benefit Boer does for controlling gastrointestinal parasites when grazing during the summer.



Assessing the Environmental Impact of the Abandoned Mines of the Central Missouri District

Dr. Samson Tesfaye

Abandoned mine sites result in barren landscapes with disturbed vegetation, acid mine drainage, anomalously high concentrations of potentially toxic elements that affect the water quality (surface and underground) and the ecosystem. The Central Missouri District (CMD) is characterized by numerous but scattered small abandoned barite, lead and zinc mines that have received little attention to date. This research work is focused on generating scientific data that characterizes the nature and magnitude of contamination and the level of environmental disturbance that may have resulted from the historic mining activity at CMD in a watershed context.

Seventy water samples were collected from Miller County streams and analyzed at Lincoln University, using an inductively coupled plasma-optical emission spectrometer (ICP-OES) for heavy metal contaminants such as cadmium, lead and zinc. The results were evaluated using the current Environmental Protection Agency's (EPA) national recommended water quality criteria. The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

The chemical analysis indicates that a number of samples exceed the criteria set by the EPA for cadmi-

um, lead and zinc. Of the 70 samples analyzed, seven exceeded the CCC limit ($0.25 \mu\text{g/l}$) set for cadmium, of which six exceeded the CMC limit ($2.0 \mu\text{g/l}$). Similarly, 18 samples exceeded the CCC limit ($2.5 \mu\text{g/l}$) for lead; however, none of these exceeded the CMC limit ($65 \mu\text{g/l}$). Three samples exceeded both the CMC and CCC limits ($120 \mu\text{g/l}$) set for zinc.

Chemical analysis is being conducted on 32 soil samples that were collected from abandoned mine sites (pits, tailings and banks) primarily from Miller County. These samples are being analyzed for heavy metals using the sequential extraction procedure adopted from Tessier et al. (1979).

A parallel investigation on the nature of the original mineralizing fluid (the parent material for heavy metal contaminants) is being conducted. Fluid inclusion analysis on samples collected from the CMD (56 sphalerite, 31 barite, 21 galena and 4 pyrite) was conducted at Virginia Tech's Geosciences Fluids Research Laboratory using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS).

The results from the soil samples, water samples and fluid inclusion studies will be investigated to determine the level of heavy metal contaminants in the soil and water and their potential impact on the environment.

Food-Fish Cultivar Development of Bluegill Sunfish (*Lepomis Macrochirus*)

Dr. James E. Wetzel II

Two bluegill lineages were created, each based on individuals representing two subspecies and multiple stocks within each species. Production performance was found to be strongly heritable with some individuals of better performing families easily reaching sizes suitable for market as food-fish in two mid-Missouri growing seasons. Both lineages have, as a consequence of the varied source populations, enough genetic variation to enable considerable future improvements in production performance. Several growth trials involving larval-through-fry stages were used to optimize feed type and size, initiation of feed training, and feeding frequency during daylight and night hours. A growth trial investigating feeding frequency for juvenile stage bluegill was also undertaken. Change of feeding protocol resulted in improved growth and survival, in some cases even with little effort. Androgenesis as a method of generating super-males has not proven feasible, in part due to extremely low viability of such treated ani-

mals. Several hybrids with bluegill were produced and evaluated for growth performance. Despite all hybrids having at least reduced fertility, only those involving warmouth sunfish were sterile. Bluegill hybrids involving redear sunfish exhibited performance at least as well as bluegill indoors. Ploidy manipulation produced triploid but not tetraploid versions of hybrids.

Bluegill brood stock subjected to multiple generations of selection as food-fish are now available for use by producers. Culture refinements developed during this project will streamline future selection efforts and provide more cost-effective options to be adopted by producers of food-fish bluegill. Super-males, if they come to be, will need to be developed through some other method. Research of reduced fertility hybrid bluegill production populations can be concentrated on those involving redear sunfish.



Bluegill cultured at high density for 112 days after swim-up, using the most effective culture regimen developed to date.



Students collecting data concluding a bluegill growth trial.

Developing Surface Coating Technology to Prevent Weathering of Lead-Bearing Solids in Soils

Dr. John Yang

Lead (Pb) contamination in soil resulting from mining and shooting activities has been identified as a threat to human health and the ecosystem. This results in increased blood-Pb levels in children through oral ingestion of soil dusts and also elevated metal concentration in surface or ground waters through leaching or runoff processes. Recently, in situ soil treatment by phosphate-based amendments is being studied as a potential cost-effective and environmentally-safe alternative for remediating Pb-contaminated soil and reducing the Pb-associated health and ecological risks. The phosphate treatment would immobilize or stabilize soil Pb by inducing the transformation of unstable Pb species to less leachable and/or less bioavailable forms, which would reduce Pb dissolution in the gastrointestinal tract and mobility in the terrestrial system.

However, in the soils contaminated with mining and shooting activities, soil Pb usually exists as relatively large solids, which would limit Pb dissolution and prevent the Pb transformation in soil during the immobilization processes, thus lowering the efficacy of phosphate treatment. This study attempts to address identified research gaps by developing a novel phosphate-based surface coating technology that would inhibit the corrosion or weathering of Pb-bearing solids in mining sites and recreational shooting ranges and reduce the health and ecological risks associated with soil Pb. It is hypothesized that surface coatings of Pb solids through formation of chemically stable metal phosphate could create a passive surface barrier preventing the Pb solids from corrosion or weathering in the soil ecosystem.

The overall goal of this project is to develop a new, effective, surface-coating technology for reducing the health and ecological risks associated with soil Pb, with an integrated approach of laboratory studies and field investigations. The specific objectives include:

- 1) Synthesis of chemically and biologically-stable metal phosphates;
- 2) Development of effective coating technology; and
- 3) Long-term risk and stability assessment of the surface coating Pb solids in soil.

The following activities were implemented and objectives accomplished during the period of 2010-2011:

- 1) The soil samples have been collected from four selected shooting ranges in Missouri and characterized for basic physiochemical properties, including pH (a measure of acidity and alkalinity), electrical conductivity, organic matter content, particle size distribution, texture, cation (a positively charged ion) exchange capacity, neutralizable acidity, macro (N, P, K, S, Mg, Ca) and micro (Fe, Mn, Zn) nutrients and total metals (Pb, Cd, Cu, Co). Lead solid species were analyzed by Scanning Electron Microscopy (SEM) in conjunction with Energy-Dispersive Spectroscopy (EDS). Data indicated that lead (Pb) contents in the soil varied and ranged from several hundred to fifteen thousand parts per million (ppm) depending upon location and shooting history. Solid Pb species were in micro-scale and highly weathering state.
- 2) Selected soil samples collected from a St. Louis, Missouri, shooting range have been treated using four phosphorous-containing amendments in an effort to stabilize soil Pb and to reduce the risks associated with soil Pb through the immobilization transformation. Leaching tests using the EPA toxicity characteristic leaching procedure (TLCP, pH = 2.88) were performed. Results showed that the amendments using KH_2PO_4 or $(\text{NH}_4)_3\text{PO}_4$

containing fertilizer could rapidly immobilize soil Pb and reduce Pb leachability by over 99 percent within a two-week period while the treatment by phosphoric acid (80 percent) or insoluble CaHPO_4 was less effective. X-ray diffraction (XRD) analyses of the pre- and post-treated soils indicated that lead carbonate, a highly bio-available species present in the untreated soil, was converted to a relatively insoluble lead species as induced by the phosphate treatments. SEM/EDS analyses revealed that phosphorus in treated soils was closely associated with lead, suggesting that the formation of chemical and biologically-stable pyromorphites (e.g. $\text{Pb}_5(\text{PO}_4)_3\text{Cl}$) could account for the Pb risk reduction in context of leachability and bio-availability.

- 3) Greenhouse pot experiments have been conducted to investigate the impacts of phosphate treatments on plant metal uptake. Results showed that the soil phosphate treatments could effectively reduce the Pb concentration in plant tissues as the reductions were at a range of 30-50 percent and varied with plant species.
- 4) Two undergraduate students majoring in environmental science were hired and trained for the project. As research assistants, the students are responsible for conducting proposed laboratory and greenhouse experiments and analyzing the samples under the supervision of the PI. These students have applied for graduate studies in environmental science at LU, starting in the spring semester of 2011.
- 5) Based on data generated from the project, two presentations were made by the students at the 2010 Lincoln University Research Symposium and 2010 Conference of the Missouri Academy of Science, respectively, and one was presented during the 2010 Environment, Energy & Sustainability Symposium of the National Defense Industrial Association.

Our efforts in 2011 will focus on developing the methods of surface coating on the Pb solids and evaluating the effectiveness and stability of the coatings through innovative techniques and state-of-the-art analytical instruments.

This study will substantially improve our fundamental understanding of lead corrosion and corrosion inhibition mechanisms in soil and provide a site-specific assessment of the phosphate treatment effectiveness within the contaminated soils that contain large Pb-bearing solids. It will also provide scientific evidence that can support large-scale implementation of phosphate-based treatment for remediation of similar contaminated sites nationwide. Results would potentially lead to a cost-effective and environmentally sound alternative for effectively remediating or restoring the contaminated soils and land, safeguarding humans and ecosystems from Pb contamination and maintaining environmental or natural resource sustainability. The technology this project is developing will eventually help Missouri and US residents living in contaminated areas because they will benefit in the context of environmental sustainability and quality of life. Furthermore, this study will also have greater economic impact as it will help minimize or eliminate the handling of hazardous Pb-contaminated soil, which will save the costs of hazardous waste treatment and reduce labor and equipment demand. Also, future medical claims by personnel involved with Pb contaminated sites should be reduced.

This project will train undergraduate and graduate students in research skills and prepare them for an environmental career, and facilitate multi-institution, multi-disciplinary collaboration on environmental research. The target audience of this research would include US citizens and Missouri residents living near contaminated sites, and environmental professionals including scientists, engineers, educators, students, administrators and decision makers.

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2010 Extension and Research Funding

Formula Funds – Research

| | |
|------------------|-----------------|
| Evans-Allen | \$ 3,359,503.00 |
| State Matching | \$ 2,117,165.00 |
| McIntire-Stennis | \$ 60,379.00 |
| State Matching | \$ 50,430.88 |
| In Kind | \$ 11,150.00 |

| | |
|--------------------------------------|------------------------|
| Competitive Grants – Research | \$ 1,702,913.00 |
| RESEARCH SUBTOTAL | \$ 7,301,540.88 |

Formula Funds – Extension

| | |
|----------------|-----------------|
| 1890 Extension | \$ 3,191,020.00 |
| State Matching | \$ 1,662,150.00 |
| RREA * | \$ 13,500.00 |
| EFNEP** | \$ 121,976.00 |

| | |
|---|------------------------|
| Competitive Grants – Extension | \$ 639,707.00 |
| 1890 Facilities Management Grant | \$ 890,142.00 |
| EXTENSION SUBTOTAL | \$ 6,518,495.00 |

| | |
|---|------------------------|
| EXTENSION AND RESEARCH GRAND TOTAL | \$13,820,035.88 |
|---|------------------------|

**EFNEP = Expanded Food and Nutrition Education Program*

***RREA = Renewable Resources Extension Act*

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Back cover photographs (from top, left to right): high tunnel at Carver Farm, youth development cabins at Busby Farm, Missouri native plant blood root, green wall at composting facility



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