


# Lincoln University

*Cooperative Extension and Research*



Annual Report 2012



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# Cooperative Extension Programs



# Animal and Plant Science



# Agricultural Economics and Marketing Program

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



*Vegetables growing in a hoop house.*

**T**he Agricultural Economics and Marketing Program (AEMP) assists small, limited resource and needy farmers across Missouri. The AEMP works with these farmers so that they can become more financially, socially and ecologically sustainable. In 2012, this was accomplished by creating efficient marketing strategies and other fiscal incentives that promoted entrepreneurship.

The AEMP developed a website for the Missouri Agricultural Products Cooperative (MAPC) at [www.moagcoop.com](http://www.moagcoop.com). This year, a financial program was developed that handled the marketing of the cooperative's products. The program also generated reports on the financial performance of the group, such as revenue, expenses and profits. The reports revealed that members made a profit from the marketing arrangements created for their produce. Price increases due to the drought boosted profits by 10 percent compared to the previous year. Also because of the drought, some members erected hoop houses (hothouses made without glass) for the fall 2012 and winter 2013 growing seasons.

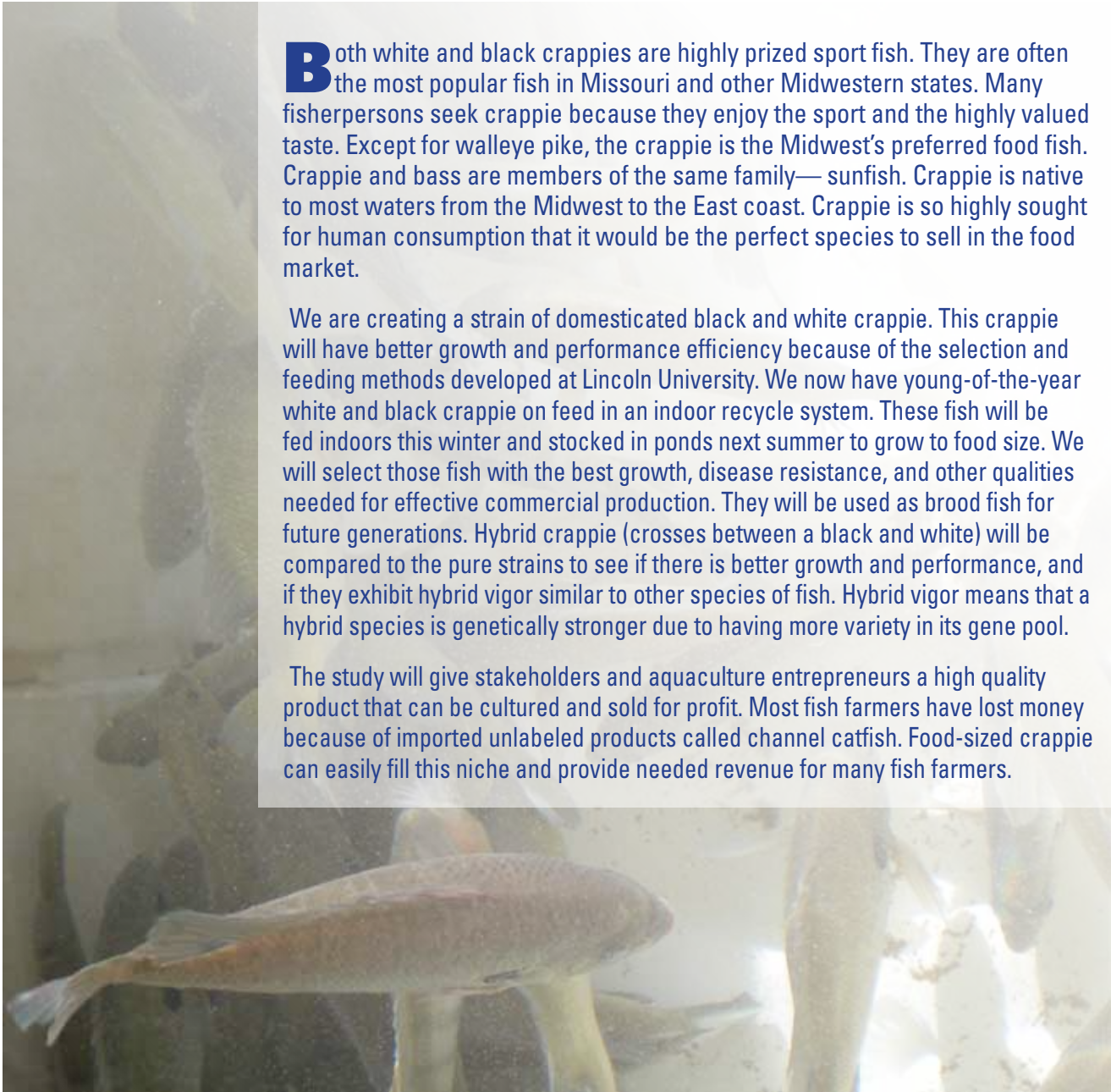
Thirty new farmers were contacted to determine their interest in the MAPC. They have agreed to start fruit and vegetable production during spring 2013. If this happens, the economic condition of citizens in the rural areas of Missouri will continue to improve, aided by the AEMP. The AEMP has published papers and given presentations that led to innovations in pricing (economics) and the marketing of goats, sheep, lamb (small ruminants) and wool. Prices of small ruminants continue to rise, having already improved this year by about eight percent.

# Aquaculture

Charles Hicks, Assistant Professor of Research, State Extension Specialist – Animal Science and Aquaculture

Cindy Borgwordt, Aquaculture Fish Specialist

Russell Gerlach, Aquaculture Specialist



**B**oth white and black crappies are highly prized sport fish. They are often the most popular fish in Missouri and other Midwestern states. Many fisherpersons seek crappie because they enjoy the sport and the highly valued taste. Except for walleye pike, the crappie is the Midwest's preferred food fish. Crappie and bass are members of the same family—sunfish. Crappie is native to most waters from the Midwest to the East coast. Crappie is so highly sought for human consumption that it would be the perfect species to sell in the food market.

We are creating a strain of domesticated black and white crappie. This crappie will have better growth and performance efficiency because of the selection and feeding methods developed at Lincoln University. We now have young-of-the-year white and black crappie on feed in an indoor recycle system. These fish will be fed indoors this winter and stocked in ponds next summer to grow to food size. We will select those fish with the best growth, disease resistance, and other qualities needed for effective commercial production. They will be used as brood fish for future generations. Hybrid crappie (crosses between a black and white) will be compared to the pure strains to see if there is better growth and performance, and if they exhibit hybrid vigor similar to other species of fish. Hybrid vigor means that a hybrid species is genetically stronger due to having more variety in its gene pool.

The study will give stakeholders and aquaculture entrepreneurs a high quality product that can be cultured and sold for profit. Most fish farmers have lost money because of imported unlabeled products called channel catfish. Food-sized crappie can easily fill this niche and provide needed revenue for many fish farmers.



# Commercial Vegetable Program

Dr. Sanjun Gu, State Extension Specialist – Horticulture



**L**UCE's Commercial Vegetable Program (CVP) received \$739,176 from proposals sent to the following programs:

- United States Department of Agriculture (USDA) Agriculture and Food Research Initiative
- Outreach and Assistance for Socially Disadvantaged Farmers and Ranchers Program (OASDFR)
- 1890 Extension and Research Capacity Building Grant
- Natural Resource and Conservation Service
- Specialty Crops Block Grant

The CVP conducted variety trials/demonstrations on watermelons, tomatoes (grown in high tunnels and open fields) and pumpkins. Trials were also done on peppers grown in Central, Southwest and Southeast Missouri. Program staff served over 300 vegetable farmers; staff made over 100 farm visits and 30 presentations. Three field days and 12 workshops were held. One newsletter and three extension publications were produced. The program leader served as the Missouri editor of "Midwest Vegetable Production Guide for Commercial Growers 2012."

Lincoln University was the core institution organizing the 2012 Great Plains Growers' Conference. A record 1,419 participants from 21 states attended.

The CVP organized the first Missouri Minority and Limited Resource Farmers' Conference.

It focused on saving minority farms, sharing USDA programs and promoting sustainable agriculture

practices. Over 130 people attended, including 68 limited resource farmers.

Several other conferences were held in conjunction with USDA agencies, University of Missouri Extension, Minority Landowner Magazine, Missouri Department of Agriculture and land grant universities in neighboring states.

The OASDFR program within the CVP aided 263 socially disadvantaged farmers in 16 Missouri counties. Staff helped four farmers receive funding from drought relief assistance and five farmers receive NRCS' seasonal high tunnel Environmental Quality Incentives Program (EQIP) cost-share funding.

Nhia Xiong, a Hmong farmer, is an OASDFR program success story. With help from the CVP staff, he now has a cold storage room, a well, and a high tunnel to extend his growing season. His sales increased by \$2,000 in 2011-12.



*Dr. Gu in a LUCE high tunnel.*

# The Innovative Small Farmers' Outreach Program (ISFOP)

Dr. K.B. Paul, State Extension Specialist – Small Farms and Program Leader, ISFOP

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

In 2012, two ISFOP Small Farm Specialists and six Farm Outreach Workers (FOWs) worked with 345 farmers and 18 community-based organizations (CBOs). Forty-four of the farmers were minority and 58 were women heads of household. The ISFOP staff organized and/or helped with many training sessions and workshops; in total, almost four hundred attended. Staff also gave one-on-one assistance to clients as needed. Two one-half acre urban vegetable farms were started. The ISFOP staff produced eight newsletters and three guide/fact sheets. Staff also compiled a book, "Success Stories," describing 16 farmers' accounts. These materials were shared with more than 1,300 people, directly or indirectly.

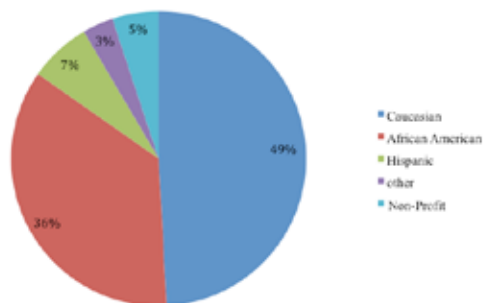
The ISFOP produced many measurable impacts this year:

- The income of 59 of its 241 core clients rose by an average of \$2,604 per farm.
- Twenty-seven farmers received grants for on-farm research, demonstrations trials and/or infrastructure development as described below.
- Eleven received Sustainable Agriculture Research and Education (SARE) Farmer-Rancher grants.
- Twelve secured Natural Resource Conservation Service's (NRCS) High Tunnel cost-share funds.
- Four were approved for the Missouri Department of Agriculture's MDA emergency well-drilling funds.

This year, ISFOP clients realized a net gain of \$252,500 in grants and higher income. The ISFOP staff assisted the International Institute of St. Louis in receiving a grant of \$77,000; this will expand its Global Farms refugee training program. The ISFOP staff also helped Cultivate Kansas City, a CBO, to obtain a \$210,000 grant from the Health Care Foundation. This grant will allow them to reach low-income neighborhoods and urban farmers in the Kansas City area.



Profile of ISFOP clients who experienced an income increase for 2012: \$153,630 for 59 out of 241 clients, an average of \$2604 per client



# Integrated Pest Management Program

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



**T**he Lincoln University Cooperative Extension (LUCE) Integrated Pest Management (IPM) program helps farmers reduce crop losses due to insects, weeds and other pests. It stresses using methods that do not harm humans or the environment. The program held two-day IPM workshops for vegetables (in 2011) and for small fruits (in 2012). LUCE trained Cooperative Extension service educators, who would later teach farmers.

As a result of the August 2011 workshop, all educators left with more knowledge of the financial and environmental reasons to employ IPM practices. A nine-month post-workshop survey showed the following outcomes:

- Twenty-two extension educators helped 779 clients in nine months, using facts from the workshop.
- Information from the workshop was used to produce 40 news pieces, including newsletters, newspaper articles and radio shows.

- IPM was discussed on 125 farm visits.
- IPM assisted 244 people one-on-one.
- Sixty-eight percent of the extension educators worked with minority and/or limited resource farmers.

Given the success of this train-the-trainer program, intensive, hands-on workshops will again be offered to both farmers and extension educators in the future. The most effective IPM methods, and how to conserve beneficial insects such as native pollinators, will continue to be stressed.



# Small Ruminant Program

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



In 2012, Lincoln University Cooperative Extension (LUCE) and Missouri State University (MSU) joined forces to sponsor two goat and sheep camps. At these camps were 4-H youth of all ages. Sixty-two youth attended the two camps. One camp was held at George Washington Carver Farm on the campus of Lincoln University; the other was at the Darr Agricultural Center at MSU. Topics included nutrition, behavior and handling, and health of the show animal. The youth learned about entrepreneurship, the ethics of showing animals, and how to select one. Some sessions were hands-on, such as fitting of the show animal and foot trimming. Other topics included body condition scoring, FAMACHA© and fecal egg counts. Most of the participants had never before attended a camp like this. Post-event surveys showed 45 percent of attendees learned lessons they would apply in the future. Not only did annual 4-H youth goat and sheep camps teach about small ruminant production, but they also allowed LUCE experts to show useful management techniques.



This year, LUCE's Small Ruminant Program also sponsored the Missouri Minority and Limited Resource Farmers' Conference. It had a great impact on the target audience. This conference also was held at Carver Farm. One hundred and twenty-five limited resource farmers attended by invitation. The topics included succession planning, small fruit and vegetable production, integrated pest management and utilizing native plants for pollinators. Many conference discussions were on the topics of small ruminant production and marketing. Attendees could view hoop houses, aquaculture and hydroponics on the farm. Participants went on tours of the small ruminant barn, the native plant pollinators' plots and another LU farm, Alan T. Busby Farm.

Forty-three percent of the attendees were new farmers (less than five years); 22 percent had farmed for 10-20 years; and 11 percent had farmed for more than 20 years. Farmers had the most interest in vegetable production (76 percent), followed by fruits (57 percent) and livestock (51 percent). Forty-one percent wanted to know more about poultry; 35 percent chose flowers. Sixty-five percent said they learned a great deal from the conference. Of those, 22 percent said they would apply for grant money to help with their farm production. All of the participants stated that they would absolutely attend this conference again. They were also excited about recommending the conference to others.

LUCE conferences such as this reach a wide variety of producers and provide information to those who might not otherwise receive it.

# Southwest Missouri Small Ruminant Program

Dr. Jodie Pennington, Southwest Missouri Regional Educator –Small Ruminants

**T**his year, Lincoln University Cooperative Extension's (LUCE) Southwest Missouri Small Ruminant Program held a meeting in the region to teach producers and the industry about small ruminants. A tri-fold display promoted our programs at events, including field days and goat and sheep sales. At Crowder College in Neosho, Missouri, demonstrations were given to show how to control browse (parts of trees and shrubs, such as twigs, flowers, etc.) and undergrowth with goats and sheep. A small ruminant advisory committee for the region was utilized to advise and complement programs.

The Southwest Missouri Small Ruminant Program worked hard to ensure minority producers, especially American Indians and Latino/as, were aware of programs for small ruminants. Good working relations were sustained with many local businesses and government agencies. Email lists for goat and sheep

producers in the region were expanded. These lists were used to promote LUCE's educational activities.

One short-term impact of the program was a more informed public. Direct contact was made with 12,096 recipients; 140,000 indirect contacts were made. Many indirect contacts were made through articles or press releases in local, regional, state and national media. Interviews for three magazines articles and three radio scripts were conducted.

Often, staff from industry contacted the program office for information. Of 251 contacts, follow-up surveys showed that 92 percent made management changes based on the assistance they received. One hundred percent of producers who attended our meetings stated that they learned new ideas; over 90 percent planned to change an existing practice. Most (95 percent) who had attended the previous year's meeting had made management changes, a midterm indication of impact.



# Value-added Fiber Program

Dr. Helen A. Swartz, State Extension Specialist – Goat, Sheep and Small Livestock

This past year the Value-added Fiber Program gave first-rate workshops to those from Missouri and eight other states. Hundreds of interested people were served by expanding the March Fiber Retreat in the southwest, working with the LUCE Southwest Small Ruminant Program and in the northwest part of Missouri, with Zelma Cleaveland.

Throughout the year, Lincoln University Cooperative Extension (LUCE) workshops were held by request. Individuals who wanted to learn to shear sheep, goats, rabbits, llamas, and alpacas were taught how to add value to the wool fibers they produce. Animal fibers with barbs were the example given for producing the best felt because they “lock in” during processing. A number of creative projects were shared with students; they could return home and share with those who could not attend the retreats, expositions, or other LUCE events. More people were reached this year--project items were taken home by attendees from eight states.

LUCE’s booth at the Missouri State Fair drew in hundreds each day. At least two spinners demonstrated every day. Many articles on display showed what can be done with raw fibers from goats, sheep, rabbits, llamas and alpacas. These articles were felted, spun, woven and crocheted. There were coats, socks, felt hats, knitted and crocheted sweaters, felted boots, felted animals, and more on display.

All LUCE programs were highlighted at the booth at the fair—programs in Jefferson City, Kansas City, St. Louis, and Crowder College in Neosho. Each day, about ten thousand people entered the Missouri State Fair Ag Building, over a 10-day period. LUCE shared all programs with families and many children. Children were able to complete and take home crafts that used fibers and other materials.

In December, an article was published in the national magazine, *Spin-Off*. It featured a shawl made by a team at the Chautauqua in Chillicothe this fall, along with color pictures.



Yarn spinning demonstration at LUCE’s exhibit during the Missouri State Fair.

# Environmental Science



# Composting Program

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

**T**he 2011-2012 composting program trained small and limited resource farmers to compost. Composting was promoted by showing various bins that can easily be made with low cost or recycled materials; bins can be built from concrete blocks, lumber, wire mesh or used pallets.

Demonstrations were given showing how to compost waste in bins, including yard waste, kitchen scraps and Japanese beetles. The “layer” or “lasagna” method was taught. Each layer must have adequate moisture, good aeration and the proper mixture of waste—high in either carbon or nitrogen.

Active worm composting was displayed in several sizes of containers. In addition, a solar thermal system was installed to maintain temperatures of 60-80 degrees F for worm composting in the winter months. Two commercial worm bins were on display. The Worm Factory® was made for household use; the Worm Wigwam was designed for medium-scale operations.

Visitors were shown how an electric heating cable heats the Worm Wigwam.

The nearby native plant garden was fertilized with Lincoln University compost. Its main use was to organically fertilize the green roof and wall at Alan T. Busby Farm. The green roof and wall are good examples of covering areas of a building with plants to help insulate it while absorbing rainwater. Compost was also applied near plants that were watered often this summer due to the long drought.

The Lincoln University Cooperative Extension (LUCE) green roof and green wall demonstrate increased biodiversity and improved environmental qualities. They also show how to conserve energy and protect structural materials. LU composting programs provide opportunities for students and the community to learn greening technologies. The results are multifold: more beautiful surroundings, improved health and higher farm incomes.



*Compost material after being harvested. At right, green roof at Lincoln's Alan T. Busby Farm.*





# Native Plants Program

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

Amy Hempen, Native Plants Technician



**T**his year the Native Plants Program (NPP) offered 30 seminars. Additionally, technical and educational assistance was provided in Kansas City, Marshall, Haywood City, Jefferson City and Columbia.

The main highlight this year was the August 30 visit of Douglas Tallamy. He shared from his book “Bringing Nature Home.” The NPP offered tours of the Native Plant Outdoor Laboratory (NPOL) on the LU campus. The NPOL displays plants, many adapted to drought and heat. Appetizers and drinks prepared using plants were served. Three hundred attended from all walks of life, including people from government, community groups, and campus. Collaborations with Lincoln University Cooperative Extension (LUCE) students and staff, Missouri Wildflowers Nursery, the Prairie Foundation,

the Capital Garden Club, and The Wild Ones made the event a great success. Evaluation results were extremely positive. Most respondents agreed the speaker was excellent and the event was well planned. Many participants offered to volunteer for future events.

A key event was the “In Touch with Nature” field day at Alan T. Busby Farm, held during September. Exhibits were on display, and wagon tours and nature walks were given by Lincoln University Extension and Research (LUCER) experts. Topics included goats, insects, aquatic wildlife, plants and more. Food samples prepared with plants were provided. There were 150 attendees from all age groups. Six LU Farmers’ Market vendors also sold products this year. Participants rated this event close to excellent.



# Youth, Family and Community Development



# Center for Community and Leadership Development

Darrell L. Martin Sr., Community Development Specialist

Lincoln University Cooperative Extension joined with City Councilperson, Mike Bohannon, and the City of Sikeston to start the Sikeston Basic Skills Program for Employees. This basic skills program assists and trains individuals in job preparation. It was designed to help those who had found it hard to find a job. The program teaches skills to make workers more employable. Attendees are made aware of the attitudes, skills and behaviors needed for success at work. Those who enroll in the program learn how to write a resume. They also develop work habits and learn about conflict resolution. Attendees are also taught how to complete applications. The program offers information on employment opportunities and market and job trends. Volunteer resources are also covered; these can help participants make informed decisions when looking for a job.

The session was held at the Sikeston High School - Career and Technology Center on Thursday nights for eight weeks. The program was made possible by employees of Tetra Pak, Alan Wire and DeWitt & Company. After completing the program, participants were paired with these companies for possible employment. This joint initiative has proven to be a success. It has helped prepare workers for employment.



# Central Missouri Youth

Adrian C. Hendricks II, Regional Educator – Youth Development

**L**incoln University Cooperative Extension (LUCE) hosted several programs that were designed to increase the knowledge and skills of Central Missouri youth. One was the Young Medics program.

The goal of the Young Medics Program is to instill knowledge in youth related to science and medicine. LUCE collaborated with the CALEB (Called to Academic & Leadership Excellence and Building Character and Confidence) Science Club of the University of Missouri for the program. The club targeted students 9-18 who showed an interest in science, especially anatomy and medicine. It provided students a hands-on approach to learning through inquiry. Twenty-five youth from Cole and Callaway counties engaged in 16 hour-long sessions.

Here are some positive results of the program:

- All surveyed students reported at least a 70 percent increase in knowledge after participating in the Young Medics Program.

- Students reported a 70 percent knowledge increase in organ and animal dissection and observation.
- Students reported a 75 percent retention rate on anatomy content related to the lower extremities.
- Students reported a 55.6 percent retention rate on anatomy content related to the upper extremities.
- Overall, the Young Medics Program reported a 74 percent effectiveness rate for youth participants improving their medical science awareness and knowledge.

The Young Medics Program collaborated with the Jefferson City Emergency Medical Technician (EMT) – Cardiopulmonary Resuscitation (CPR) Training Unit, the LUCE Small Ruminant Program and biology faculty at Lincoln University.



# Paula J. Carter Center on Minority Health and Aging

Yvonne Matthews, Coordinator

Deborah Jenkins, Research Assistant I  
Karen Galbreath, LPN, Community Liason

**D**uring the 2011-2012 fiscal year, Lincoln University Cooperative Extension's (LUCE) Paula J. Carter Center on Minority Health and Aging (PJCCMHA) made a successful grant application to start the program Breast Cancer Awareness and Education for Underserved Minorities (BCAEUM). This program was made possible through funding from the Mid-Missouri Affiliate of Susan G. Komen® for the Cure. The BCAEUM program increased knowledge about breast health management and prevention.



Eighty-one participants completed the BCAEUM program. The four-part curriculum—"Breast Health...4 What?"—was presented by Wellness Outreach Workers (known as the WOW team), who are nurses. Eighty class sessions were conducted this year. Seventy-three participants increased their knowledge from an average of 75 percent on the pretest to an 83 percent average on the posttest.

This outreach program established new partnerships, increased Cole County's program participation and shared health literature. The program gave out 2,330 educational materials. This number includes BCAEUM brochures, session handouts and resources from the PJCCMHA book nook.

Participants were engaged by the center's health classes. They opened up and shared how the program helped them. As a result, the following outcomes were identified:

- Participants in Cole County indicated that they became more conscious of the need to adopt a healthy lifestyle.
- Participants proactively sought out health information from credible sources available at the center in the book nook.
- Participants became more aware of ways to manage their personal health and scheduled clinical breast health exams.



# Cooperative Extension Satellite Offices



# Kansas City Urban Impact Center

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

**S**everal programs and workshops were held at Lincoln University Cooperative Extension's (LUCE) Kansas City Urban Impact Center (KCUIC). Here are some highlights:

The 4-H Character Counts Program helps underserved youth by providing afterschool programs in the Kansas City Public Schools and charter schools. During the 2011-2012 school year, 130 youth were enrolled each week. Teachers and afterschool workers agreed that Character

Counts improved behavior and reduced bullying. The youth were taught to focus on modeling the six pillars of character: responsibility, respect, trustworthiness, fairness, caring and citizenship.

KCUIC also provided programs to aid seniors in leading a healthy lifestyle through hands-on activities. They studied health, physical fitness and nutrition. Many of the seniors live on fixed incomes, at or below the poverty level. Programs reached an average of 35 seniors per week. Their ages ranged from 62-96. Ninety-eight percent of the seniors served at this location in central Kansas City were African American. Our program has helped seniors become more active, less

isolated, and more motivated to make healthy choices.

KCUIC gives low-income individuals and communities alternatives for addressing food insecurity. In 2011, the United States Department of Agriculture (USDA) reported that the prevalence of very low food security is greatest for women living alone, black households, and those with annual incomes below 185 percent of the poverty line. By teaching people to grow their own food, food insecurity is reduced. The Minorities in Agriculture Natural Resources and Related Sciences (MANRRS) club was started this year with six students as members. MANRRS provides youth the opportunity to sell their produce, which helps them financially. Growing and eating nutritious foods helps to prevent chronic diseases in children and adults. The club

- generates ideas for profitability,
- creates green jobs,
- prepares students for a potential career in agriculture, and
- teaches entrepreneurial skills and how to profit from commercial farming.

There were 102 program participants.



# St. Louis Urban Impact Center

Patrice G. Dollar, Regional Educator

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



**S**everal programs and workshops were held at Lincoln University Cooperative Extension's (LUCE) St. Louis Urban Impact Center (SLUIC). Here are some highlights:

This year, 48 people enrolled in the Workforce Development workshop. The program's goal is to help people obtain long-term employment. Workshops ran for eight to ten weeks. They included training in customer service, job readiness, mock interviews and computer literacy. Pre- and posttests were conducted to assess program effectiveness. Participants were also asked to evaluate the program. Four participants got a job four to eight months after the workshop.

During the 2011 tax season, LUCE volunteers helped twice the number of limited resource families prepare returns than during the 2010 tax season. The volunteers assisted with 125 federal and state tax returns, resulting in over \$211,000 in refunds. In addition, the families eligible for the program saved a total of more than \$18,000 in tax preparation fees.

Because of the horticulture 2012 Summer Program, two students answered questions about gardening from a community group—Gateway Greening. One SLUIC participant received a scholarship of \$2,000 to start a community garden.

A new urban farm in the St. Louis metro area was developed. This means that LUCE staff now assist at six urban farms in the St. Louis area. The Community Supported Agriculture (CSA) program provided fresh produce to 20 needy families for 20 weeks each. The value per family was \$25-\$40 per week, with an average \$28. An estimate of the first year's proceeds from this program is \$5000.

The Gates Millennium Scholarship recipient was Mark Vassell, President of the McCluer High School Men on Business chapter, another LUCE SLUIC program. With this award, Vassell's college education cost is paid for until he earns his doctorate.



# Southeast Missouri Outreach Center

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

**S**everal programs and workshops were held at Lincoln University Cooperative Extension's (LUCE) Southeast Missouri Outreach Center. Here are some highlights:

The LUCE Southeast Missouri Outreach Center's Summer Enrichment program teaches youth by engaging them in hands-on learning. Topics covered this year included science, technology, engineering, agriculture and math. The program also strived to reduce childhood obesity by sharing healthy living ideas and increasing physical activity.

The program met Monday through Thursday from 8 a.m. to 3 p.m. in Sikeston and Caruthersville. It served 150 youth in kindergarten through eighth grade. The students' weight, height and Body Mass Index (BMI) were recorded at the start and end of the program. On average, there was a 23 percent loss of weight. The average decrease in BMI was two points. Students were active at least two hours per day. Physical activities included kickball, football, swimming, bowling, softball, volleyball and basketball. Students were also involved in stepping (synchronized performance based in African-American culture), exercise routines, flag and dance.

The program was a success because the center collaborated with many agencies. These included the United States Department of Agriculture (USDA) Summer Food Program, Lincoln University Cooperative Extension State Specialists and the Missouri Department of Conservation. Other partners were AmeriCorps, the Malden Bootheel Youth Museum, University of Missouri Extension, the Expanded Food and Nutrition Education Program (EFNEP) and local groups.

One parent stated that the program was a blessing to her, and it made a huge difference in her child's life. Several other parents expressed they are also happy that by participating in the program they save \$80 per week in daycare costs or day camp fees.

A fifth grade student started the program overweight; he was considered a "couch potato." Before the program, his mom had said, "Good luck with getting him to go outside to participate in activities." To her surprise, he lost 10 pounds. This student enjoyed the exercise so much that he will play Little League football in the fall. He cannot wait until this program begins next summer.



# Fort Leonard Wood Outreach

Andrew Cempa, Extension Liaison



The LUCE Fort Leonard Wood (FLW) office forged links within the community to develop programs that would benefit the military population in Central Missouri. During 2012, the FLW office kept in contact with military base leaders who could influence the overall purpose of the program.

Goats and/or sheep were used as an alternative to mowing through the grazing of non-primary use landscape or pasture areas. This reduced reliance on oil-based fuels and was more environmentally friendly. And, it did not reduce employment locally.

This office also talked with base commanders in charge of contracting. Recommendations were made that they regularly buy small numbers of rabbits and chickens for use in survival training in the U.S. Army Sapper Leader Course.

The FLW office worked with the Army Career and Alumni Program (ACAP) to share LUCE programs. This was done at job fairs and professional shows and by using other methods to access those in the FLW area. At least two hundred people were reached directly and many more indirectly. The FLW office worked with several youth and family groups to create joint programs. LUCE continues to seek funding for new and innovative family support programs that will combine our collective talents and skills.

A new effort where community and the military work together is the Sustainable Ozarks Partnership. This group is comprised of businesses, the military base, academic institutions and private individuals. It was designed to enhance the social and economic success of FLW and the surrounding area. It also fosters individual success. The FLW office participated in several focus groups on energy, education and family.

The FLW office took part in many events this year. Several participants placed in the National Science Foundation junior and senior high school science fairs. The office also participated in meetings and symposia about family and wounded warrior programming.

# Extension Program 2012 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

	Adult Direct Contact	Adult Indirect Contact	Youth Direct Contact	Youth Indirect Contact	
<b>Program</b>					<b>Totals</b>
Food Safety	1314	1835	2108	613	5870
Family/Youth Development	3548	6351	14431	13666	37996
Community/Leadership Development	729	315	115	50	1209
Global Food Security	5778	6371	2649	2861	17659
<b>Totals</b>	<b>11369</b>	<b>14872</b>	<b>19303</b>	<b>17190</b>	<b>62734</b>



# Cooperative Research Programs



# Animal and Plant Science



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

Dr. Zahra Afrasiabi, Associate Professor of Chemistry

**T**he main goal of this project is to develop a device that can quantify real-time changes in concentrations of Luteinizing Hormone (LH). There are very few assays known for detecting LH in the blood of domestic animals. The most sensitive are useless for farmers because they require radioactive isotopes (of the same chemical element, but with a nucleus that decays and emits radiation). Another major disadvantage of existing assays is that they require large samples. There is a critical need to develop a novel and accurate sensor that will detect LH.

Our long-term goal is to develop a nanotechnology-based sensor to accurately detect LH in sheep. Our hypothesis is that gold nanoparticles (microscopic particles) joined with biomolecules (molecules in a living organism) or antibodies (a substance that the body produces to combat disease/antigens) will create an excellent sensor. It will provide a new way to develop a sensor that can accurately detect LH. Our hypothesis is based on the experimental observations from our detailed studies as a proof of concept. Gold nanoparticles (AuNPs), which are ultraviolet (UV)-visible and are plasmon (how the movement of free electrons is measured) absorbers, are an excellent sensor for detecting biomolecules or antigens in concentrations lower than parts per billion (ppb). Our proof of concept studies have established the following results:

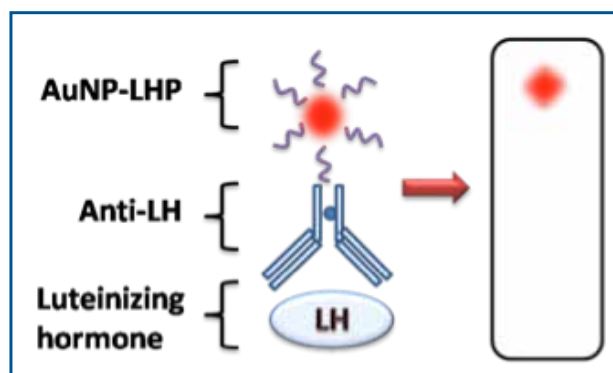
- The Anti-protein A joined with AuNPs is very effective at detecting low concentrations of protein A.
- The antibody of LH (Anti-LH) has a high affinity and selectivity toward identifying the LH of sheep.
- The peptide (linked amino acid, shorter than a protein) created by AuNP joined with LH-avid is able to recognize low concentrations of the antibody of

LH; this has been shown using detailed immunoassay experiments.

So far, a novel LH-peptide sequence has been developed. In addition, its affinity towards Anti-LH was evaluated using the ELISA technique. Based on this experimental evidence, the focus of the present study is to perform real-time field trials to utilize an 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-peptides against the LH of sheep.

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

The outcome of this project has a direct impact on increasing the genetic quality in the herd/flock, the economics of production and the increased use of artificial insemination by small farms. It is a breakthrough in the design of nanosensors for accurate detection of biomolecules. Both farmers and scientists benefit from the outcome of this research.



# Performance of Katahdin Ewes Grazing Tall Fescue Pastures

Dr. James Caldwell, Assistant Professor of Animal Science

**A**lternative grazing schemes have become much more popular in recent years. Rotational grazing is used the most. However, its value for small ruminants is unknown. This is especially true of Katahdin hair sheep.

The performance, reproductive rates and parasite load of yearling Katahdin ewes were studied. These ewes grazed tall fescue (E+) that was toxic. Sheep eating this fescue all the time were compared with those in rotational grazing in late spring through summer. Over a two-year period, yearling Katahdin ewes (n = 50) were grouped by body weight. They were then randomly set on one of five one-acre pastures consisting of two treatments: (1) continuous (C; five replications) or (2) four-cell rotation (4R; five replications). The treatments did not affect body weight at the beginning and end

of breeding. Breeding and final average daily gains, final body weight and total gain were also not affected by treatment. The beginning breeding body condition score (BCS) tended to be greater for C than for 4R. End breeding and final BCS and beginning, end of breeding did not differ across treatments. Neither did the final FAMACHA© scores, which estimate the parasite load. Lambing rates and the rate of multiple births were greater with 4R than with C. The number of lambs per ewe exposed did not differ across treatments.

The results of this study suggest that rotationally grazing yearling Katahdin ewes on E+ pastures in late spring through summer might not improve performance, parasite burden or the number of lambs per ewe exposed. However, it might increase lambing rates and the frequency of multiple births.



*Grazed vs. ungrazed endophyte-infected tall fescue pastures.*



*Yearling Katahdin ewes grazing endophyte-infected tall fescue pasture in late spring through summer.*



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

Dr. Thomas R. Omara-Alwala, Professor of Agriculture

**B**luegill is a cultivated sport fish in the area of the U.S. served by the North Central Regional Aquaculture Center (NCRAC). It is the most popular of the sunfishes. Its importance as a food fish is still being researched.

No commercial feeds are specially made for the sunfishes. This is because their nutrient needs are unknown. Instead, costly feeds, such as trout diets with protein levels above 40 percent, are often used for bluegill production.

In 2012, bluegill nutrient requirements were researched. In this way, least-cost feeds could be developed. The objective was to find the best dietary protein level and protein-to-energy ratio to grow young bluegill. Bluegill fingerlings (young fish) or juveniles between twenty and thirty grams were studied in a water recirculating aquaculture system (RAS).

It was found that a diet with about 38 percent fishmeal protein was best for growing young bluegill starting with an average weight of twenty-five grams fed for sixteen weeks in an RAS. Using this diet could save commercial producers a great deal in feed costs.

Analysis of the data from the protein-to-energy investigation is still in progress.



# Food Web Ecology: Ozark River Community

Dr. J. Daren Riedle, Assistant Professor of Natural Resources and Wildlife Management



**R**esearch is now being conducted on the food web of macroinvertebrates (animals without backbones that can be seen with the naked eye), salamanders and turtles in the Niangua River. This study looks at the river above and below Bennett Springs, Missouri. Measurements of the level of carbon and nitrogen isotopes (variations of the same element) were taken. Energy pathways showing how food moves through the aquatic system can be seen by reviewing these isotopes. This research will discover what food these aquatic animals eat, leading up to the high level feeders.

The first round of analysis showed that above and below Bennett Springs, there were differences in nitrogen levels. This suggests that the sources of nitrogen in these two parts of the stream are not the same. Based on early analyses of the carbon and nitrogen isotopes, high zinc and copper levels in snails, mussels and crayfish have been found; these are the main food of aquatic turtles and hellbenders (large aquatic salamanders). These analyses are still in their initial stages.

Continuing lab work and field collection of samples through 2013 will show a more complete image of energy and the possible pollutant pathways in the Niangua River system. Samples from more river systems will be taken in 2013 so the differences in energy and pollutant flows in northern Ozark streams can be mapped.



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

Dr. Bruce Shanks, Assistant Professor of Research – Animal Science

**G**oats are popular with small landowners in the central U.S. Goats are also prone to infection by parasites. In the past, parasites were controlled with commercial chemicals. However, many parasites have become resistant to these compounds. This research seeks to use the host animal's natural immunity. At the conclusion of this research, the animal's parasite resistance through genetic selection should be boosted.

First, does were evaluated for resistance to internal parasites. These does were assigned to one of two selection lines: (1) high or (2) low. Bucks were bought from private breeders based on their parasite resistance. Does were mated to corresponding high or low line bucks (low to low, high to high). The kids resulting from each line will be selected based on

parasite resistance. They will be crossed with high line and low line bucks, respectively, to produce the next generation. After this, lines will be closed. From then on, the most parasite-resistant animals from the high line and the least parasite-resistant animals from the low line will be mated. This will continue for several generations. The typical production traits will be documented, such as parasite resistance, weight gain, fertility and general health, to see if they correlate with the selection for parasite resistance.

Genetically selecting goats that are more resistant to parasites might give producers a new option to lessen the negative effects of parasitism. It might also reduce dependence on commercial chemicals. Finally, it is compatible with modern trends toward sustainable agriculture.



# Establishing a Foot Rot-resistant Katahdin Sheep by Genetic Marker-assisted Selection

Dr. Tumen Wuliji, Assistant Professor of Animal Science

**F**ood animal diseases affect production economics, animal welfare and human food safety. Foot rot is a highly contagious disease. It is particularly likely to infect goats, sheep, cattle and some wild ungulates (mammals with hooves). However, sheep with certain forms of genetic variation tolerate foot rot infection and infectious challenge. Therefore, this proposal will focus on the genetic screening, identification and selection of a foot rot-resistant genotype within hair sheep breeds or flocks. It will also establish a line of sheep with high resistance to foot rot disease. Foot rot-resistant genotypes will be investigated and examined for a viable selection trait. This study will estimate how resistance might be inheritable. It will also look at other correlated factors in relation to the gene marker or immune response parameters in animals. Specific objectives are to (1) select foot rot-resistant genotype sheep by using the DQA2 gene marker and other alternative quantitative trait loci (QTL) markers (portions of DNA that are linked to a certain trait) that supposedly come from sheep; (b) develop an evaluation system to characterize foot rot, resistant heritability and correlated traits; (c) investigate the foot rot pathogenic (able to cause disease) bacteria strains and host resistance immune response in vitro (using a test tube, etc.) and in vivo (using living organisms); and (d) establish an on-farm biosecurity protocol for foot rot disease prevention, control and management.

At LU's George Washington Carver Farm, a base population of Katahdin ewes ( $n = 120$ ) and 30 rams (Katahdin,  $K = 16$ ; Dorper,  $D = 7$ ; Texel,  $T = 7$ ) were acquired. Ewes were assigned equally to two dam (ewes at lambing) groups: (1) a foot rot-resistant selection flock (SF = 60, Lincoln University farm station flock), which were bred to Katahdin rams and (2) a crossbreed genotype flock (CF = 60, purchased from

producers). The SF animals will be bred once a year during the fall breeding season within the breed (K) mating group: as a foot rot-resistant selection flock, four K rams will be single-sire mated with 60 ewes in the first two years and 80 ewes in the third and fourth years to establish the SF. The CF ewes (K) will be crossbred with Dorper and Texel rams (first and second year); their F1 (first generation) progeny will be backcrossed to one of the two sire breeds (third and fourth year). Thus, crossbreed genotype flock (CF) ewes will be mated to four D rams in the fall season of the first year and to four T rams in the second year, to generate crossbreed F1 progeny groups of  $\frac{1}{2}K\frac{1}{2}D$  and  $\frac{1}{2}K\frac{1}{2}T$ . Then the crossbreed F1 ewes will be backcrossed to Texel ( $n = 4$ ) and Dorper ( $n = 4$ ) sires in the third and fourth year of the project to generate F2 (second generation) three-breed crosses of  $\frac{1}{4}K\frac{1}{4}D\frac{1}{2}T$  and  $\frac{1}{4}K\frac{1}{4}T\frac{1}{2}D$ . Therefore, after four breeding seasons, there will be one selected breed (Katahdin) and four crossbreed genotypes ( $\frac{1}{2}K\frac{1}{2}D$ ,  $\frac{1}{2}K\frac{1}{2}T$ ,  $\frac{1}{4}K\frac{1}{4}D\frac{1}{2}T$  and  $\frac{1}{4}K\frac{1}{4}T\frac{1}{2}D$ ) available for the foot rot-resistant challenge, genotype marker typing, selective breeding and genetic linkage analysis.

In the 2011 and 2012 breeding seasons, the project implemented its initial two-year breeding plan. It also completed DQA2 gene marker screening tests for the base flocks (SF and CF) and for the F1 progeny. In addition to foot rot disease monitoring of the SF and CF flocks, 24 participant farmers' flocks were inspected for foot rot diagnostic scoring, and bacteria swabbing was conducted along with foot rot bacteria culturing and identification. An on-farm biosecurity protocol is being developed for foot rot outbreak seasons. Genetic marker-assisted selection for foot rot resistance in sheep is a modern approach to producing food use animals. This project might develop a strain of sheep that are able to thrive and perform better in foot rot-prevalent farming environments.

# Environmental Science



# Enhanced In Situ Biodegradation of Pesticides under Modified Soil Conditions

Dr. Frieda Eivazi, Professor of Agriculture, Chair of the Department of Agriculture and Environmental Sciences, and Associate Research Director

Dr. Bei Chu, Postdoctoral Research Associate

**A**lthough agricultural chemicals have been important in improving farm productivity, their overuse has resulted in contaminated surface and groundwater. Groundwater is the major source of drinking water for about half the U.S. It is also the source for nearly all of its rural population. Recent studies show that many wells in rural areas are polluted with agricultural chemicals. This pollution means that pesticide levels are above the drinking water standard or health advisory level. As a major agricultural state, many of Missouri's farms have become point or non-point sources of pesticide contamination of soil and water. A point source is a specific area known to cause pollution, such as a factory. Nonpoint source (NPS) pollution can be the result of a number of causes, including rain or snowmelt that carries pollutants, depositing them into the water system.

Biofilter technology uses microbes in soil to break down agrochemicals (chemicals used in agriculture). The goal of this study is to develop a biofilter system

that adapts to the soil and environmental conditions of Missouri. It will be used to treat and dispose of selected pesticide wastes on farms. In this way, biofilter technology and its potential application to prevent the buildup of pesticide pollution will be understood.

The physical and chemical properties of soil and biofilter materials, such as pH, water-holding capacity and lignin (a substance found in and between the cell walls of plants) content were measured. Several mixtures of biofilter materials were designed. A ninety-day experiment was conducted to see how two common pesticides (atrazine and glyphosate) would degrade. These pesticides were tested using four different biofilter materials and soil alone. Analytical methods for pesticides are under development. Pesticides remaining in the samples are being measured along with their breakdown kinetics. The overall impact of this study will be the creation of a low-cost and simple method to reduce point source pesticide pollution.



# Groundwater Flux of N, P and Organic C Concentrations in a Hinkson Creek Floodplain: Geochemistry of Forest and Agricultural Microcosms

Dr. Abua Ikem, Assistant Professor, Agriculture and Environmental Sciences (Lincoln University)

Dr. Jason Hubbart, Assistant Professor, Forest Hydrology and Water Quality (University of Missouri)



*Data collection at the agricultural land site.*

**N**ew methods for managing floodplains are critical where urban and climate impacts jointly harm the water system. In such areas, there is more flooding and damage caused to many at-risk ecosystems; there are also more transported nutrients.

The geochemical makeup of a Hinkson Creek floodplain in Central Missouri was studied. Over a century ago, it was a wildland ecosystem. Human activities (farming and urban growth) have likely spoiled the water quality of the Hinkson. Also, stormwater runoff has increased with the number of roads, roofs, etc. Altered floodplains and rechannelization (changes to the course of waterways) are also problems.

For this study, two microcosms (small ecological communities) were used: BHF (bottomland hardwood forest) and agricultural land (Ag site).

The study had the following objectives, all related to the floodplain:

- to provide data on subsurface geochemical behavior (retention and release) of nitrogen (N), phosphorus (P) and organic carbon (C) in bottomland hardwood forest and agricultural land;
- to provide seasonal patterns of N, P, organic C and interrelationships with trace elements in both surface and subsurface waters; and
- to create a model of nutrient retention and release to better predict nutrient chemistry.

Several weather-monitoring stations were installed at BHF and Ag sites. From June 2011 to June 2012, monthly water samples (subsurface and surface) were taken and analyzed for water quality variables.

Analyses from June to November 2011 indicated 21, 35 and 22 percent greater TC (Total Carbon), Total Inorganic Carbon (TIC) and TN (Total Nitrogen), respectively, in BHF, and eight percent less Total Organic Carbon (TOC) in BHF relative to the Ag site. From June to December 2011, there were 41 percent greater Total Dissolved Solids (TDS) in BHF and 28 percent less orthophosphate in BHF, relative to the Ag site.

Research continues to discover optimal methods to manage Midwest floodplains.

# Hydrologic Processes Controlling Stream Water Quality in a Missouri Claypan

Dr. Fengjing Liu, Assistant Professor of Research – Hydrology

Information on hydrologic (water-related) processes is necessary to understand the control of contaminants in stream water within agricultural watersheds. Watersheds are landforms that carry water shed by land after it rains or snows. Since October 2011, intensive field sampling has been conducted in a small claypan soil watershed in Mid-Missouri. A claypan is a layer with more clay than the soil above it. It makes water move more slowly downward through the soil.

This project trained a graduate student and a postdoctoral researcher in the field of water quality. Over 50 samples were collected from streams, seep flows (shallow subsurface water that returns), rainwater (gathered in a rain gauge during storms) and

groundwater. This study showed that stream water was mainly controlled by rainwater, seep flow and baseflow (where top and claypan soils interface). It was not controlled by groundwater below the claypan layer. This information was used to understand watershed management and land use planning.

This knowledge benefits farmers. By decreasing contaminants such as herbicides and pesticides from being transported, they will not end up in the streams and other vulnerable areas within watersheds. This is the first time hydrologists have recognized the importance of seep flow in regulating stream flow. Thus, Missouri farmers benefit by the improved management of commonly used fertilizers and herbicides.



# Abandoned Mines of the Central Missouri Mining District

Dr. Samson Tesfaye, Associate Professor of Research – Environmental Science

**T**he Central Missouri Mining District was active from 1820 until the 1950s. It had many small barite, lead and zinc deposits. Parts of Miller, Moniteau and Morgan counties lie within the district; it extends for about 2,000 square miles. It is spread over four watersheds: Lake of the Ozarks, Lamine, Lower Missouri-Moreau and Lower Osage. This study looks at the problems that might have been caused by this historic mining activity. Data about the amount and types of contamination was collected; other ways in which the environment has been disturbed were also studied.

One hundred and seven water samples and sixty-seven soil samples were collected from Cole, Miller, Moniteau and Morgan counties. Of these, seventy water samples and thirty-two soil samples were analyzed. The remaining soil and water samples will be analyzed using an ICP-OES (inductively coupled plasma-optical emission spectrometer); this device detects trace minerals based on the radiation they

emit. The soil samples will also be analyzed using X-ray diffraction (XRD); this means that studying the behavior of X-rays beamed at the soil will give information about its makeup. The data will be compared with prior studies by the United States Environmental Protection Agency (USEPA). In this way, an assessment can be made of the impact these historical mines have had on the environment, mainly on the water quality.



*Above: Abandoned mine turned into a lake, Miller County. Right: Remains (ruins) of an ore-crushing/milling facility, Moniteau County.)*



# Identification and Use of *Escherichia coli* (*E. coli*) DNA markers for Tracking Sewage Pollution in Water

Dr. Guolu Zheng, Assistant Professor of Research – Microbiology

Identifying sewage contamination in water is very important to prevent disease outbreaks. It is also needed to fix impaired water systems. This study seeks to identify the *Escherichia coli* (*E. coli*) genetic markers, or DNA fingerprints, that are unique to human feces. The newly identified DNA fingerprints will then be used to develop a DNA-based method that tracks sewage pollution in water.

The method of bioinformatics (the study of how biological data is stored, retrieved and analyzed), was used to compare a collection of over 20,000 genes and DNA fragments of *E. coli*. The *E. coli* used was reported to be associated with fecal and intestinal samples from different hosts, mainly human. Using bioinformatics, these genes and

fragments were compared and screened for the presence of the human DNA fingerprint for human feces-specific DNA fingerprints of *E. coli* cells. As a result, 10 candidate genes and fragments were found to be highly associated with human feces. Whether they were specific only to humans was further assessed by the technique of polymerase chain reaction (PCR) assays. These were compared to a panel of over 500 strains of *E. coli* isolated from 11 animal species, including human, chicken, cow, deer, duck, goat, goose, horse, pig, raccoon and turkey.

Fragment 2833, one marker of the *E. coli* DNA identified by the PCR assays, can be used to differentiate *E. coli* strains of human sources from those of all others. This result indicates that fragment 2833 might be useful as a DNA fingerprint for identifying sewage pollution in water.

# Human Nutrition



# Impedance Biosensor Using Dielectrophoresis for Detection of Extremely Low Levels of *E. Coli* O157:H7

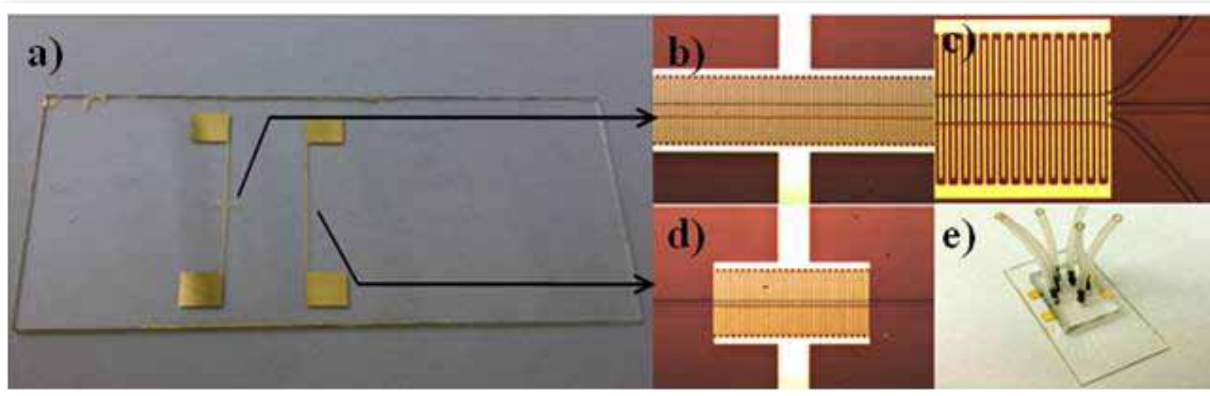
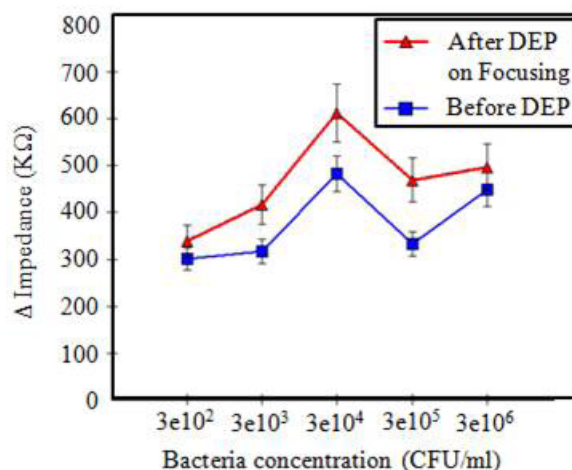
Dr. Majed El-Dweik, Associate Professor of Physics

In August and September 2012, there were 30 or more outbreaks from foodborne pathogens in the US. At least 24 states were affected. The food involved included cantaloupe, cheese and turkey jerky. The culprits were *E. coli*, Salmonella, and Listeria. It was reported that at least 300 people were hospitalized; there were two deaths. Such outbreaks are a reminder that there is a need for better diagnostic methods. If these problems are spotted early, products can be removed. This lessens the harmful effect on human health and the economy due to it costing billions of dollars to recall products and sterilize contaminated areas.

To solve this problem, our lab creates devices (biosensors) that can be used in the area of food safety. These devices are designed to detect bacteria in food samples. These devices reveal if bacteria are present in the sample; they also show the type of bacteria that is present and in what amounts. Other methods take from one to four days for the results, but our biosensor needs only three hours. Our earlier devices were successful, and the results were published. Now we

are using a new method that (dielectrophoresis).

Dielectrophoresis is a technique that looks at the electrical activities of cells or pathogens. Our latest biosensor can detect much smaller concentrations of bacteria, as low as  $3 \times 10^2$  CFU/ml, which is less than the size of a grain of salt. This is one 1,000 times better than the lowest detection limit of other impedance biosensors. This is a significant step in the field of food safety.



*Fabrication Steps: (a) patterned gold electrodes on a glass substrate (b) focusing electrode (c) magnified view of the interdigitated electrodes (d) detection electrode (e) fabricated impedance biosensor.*

# Plant and Soil Science



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

Dr. Keesoo Lee, Professor of Biology

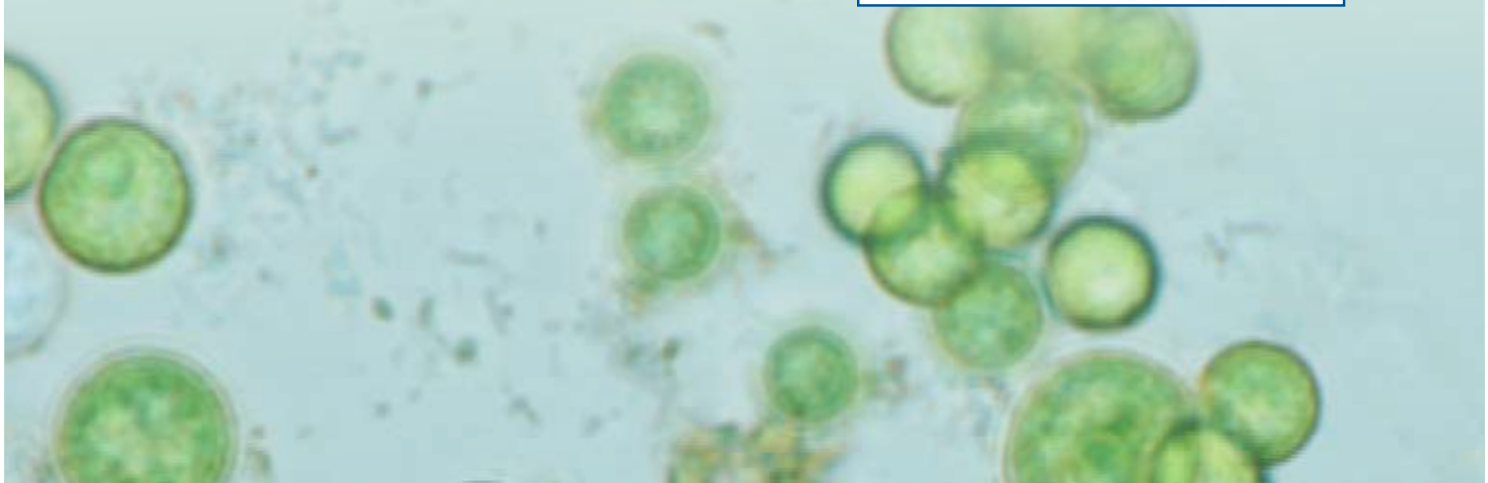
**T**he Center for Bioenergy focused its research on microalgae. This research was multidisciplinary; it involved the areas of phycology (the study of algae), microbiology, chemistry and engineering. It was also a joint effort of the following: Lincoln University, Missouri University of Science and Technology, Missouri electric power cooperatives and the United States Department of Agriculture - Agricultural Research Service (USDA-ARS).

This project worked to solve problems related to microalgal biomass production (where algae is harnessed for energy). It also explored coupling bioproduct production with waste management, to yield dual benefits.

Carbon dioxide, a greenhouse gas, is the most valuable resource from flue gas (gas from the burning of fossil fuels). It can be used to grow the algal biomass while at the same time decreasing pollution. To grow algae in toxic matter (such as flue gas), it is necessary to understand the stress-stabilizing responses of the algae. In that way, the biomass yield can be increased. For large-scale cultivation, nutrients and both water source and quality are important factors to be researched. The most suitable algae can be cultivated year round, undisturbed by invading undesired algae.

Microalgae are a great source of high value products, such as sunscreen pigments, antioxidants (that protect cells from unstable molecules), natural food dyes and enzymes.

Students benefit through hands-on learning related to this research. This study enables the integration of knowledge across disciplines in bioenergy-related sciences and engineering.



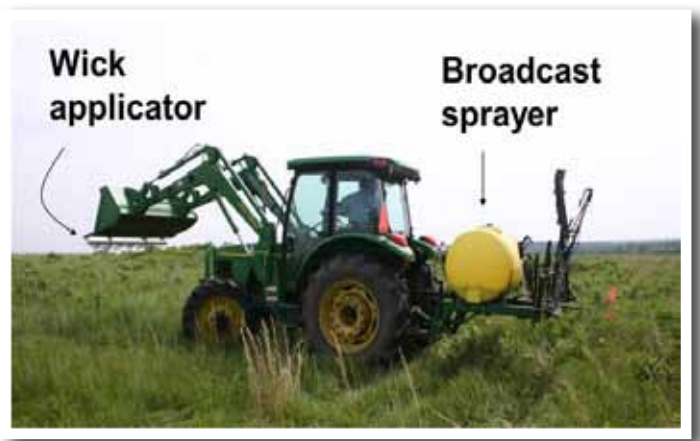
# Effects of Wick-applied Herbicides on Invasive Sumac and Desirable Forbs in Missouri

Dr. Kirsten Stephan, Assistant Professor of Biology

**T**he Missouri native species sumac (smooth and winged varieties) is encroaching on what remains of prairies. The goal of this study was to find an herbicide and application method that would kill sumac but preserve the diversity of forbs (herbs that are not grasses). The study was funded by the Missouri Department of Conservation (MDC) and conducted jointly by MDC and Lincoln University. Three prairies in west central Missouri were studied. At each prairie, eight 6 × 12 meter study plots were set up in 2010. In May of 2011, three groups of two plots per site were chosen randomly to be treated with one of three herbicides. The final two plots per site were the control, with no herbicide. Herbicides were applied via two methods. The wick method wiped the pesticides onto plants; the broadcast method uniformly applied the pesticide to the entire area. The herbicides Tordon® 22K (wick application), Buccaneer® Plus Glyphosate (wick application) and Pasture Guard® (broadcast application) were used. In July and August during both 2010 and 2011, sumac stems were counted; the presence or absence of each forb species was recorded for each plot.

In 2010, before applying herbicide, sumac stems and branches were counted, along with forb richness:

This study found that the more sumac per plot, the less forb richness there was. Wick-applied Tordon® and broadcast-applied Pasture Guard® equally and maximally reduced sumac stems and branches. Tordon® reduced sumac by 80 percent; Pasture Guard® reduced sumac by 95 percent. However, only wick-applied herbicides had no negative effect on forb richness that could be detected. Based on these results, the use of wick-applied Tordon® is advised to counter sumac encroachment. In this way, high forb species richness can be maintained.



	Sumac Stems	Sumac Branches	Forb Richness
Paintbrush Conservation Area	1.2 m <sup>-1</sup>	2.3 m <sup>-1</sup>	12.2 m <sup>-1</sup>
Wah-Kon-Tah Prairie	2.4 m <sup>-1</sup>	4.9 m <sup>-1</sup>	9.9 m <sup>-1</sup>
Risch Conservation Area	2.7 m <sup>-1</sup>	8.1 m <sup>-1</sup>	8.3 m <sup>-1</sup>

*Note: m<sup>-1</sup> means "per meter"*

# Reducing Arsenic Accumulation in Rice Grains through Cultivar Selection and Water Management Practices

Dr. John Yang, Professor of Research – Soil Chemistry

**H**igh levels of arsenic (As) in rice grains are a potential threat to human health and food safety in the U.S. This became a national story on September 12, 2012, after it was broadcast by CNN Consumer Reports. The Food and Drug Administration is now focusing on the risks of arsenic in U.S.-produced rice. Scientists need to find ways to reduce the arsenic accumulation.

To minimize the arsenic uptake by rice, field experiments were conducted to see how cultivars (varieties) of rice would respond to soil arsenic level. Three cultivars of rice were used. They were grown in both arsenic-treated and untreated soils under flooding and using wet-dry management practices. Results showed that the grain yield depended on the cultivar. It was also influenced by the soil arsenic level and water management practices. Arsenic-resistant varieties yielded more grain and had lower grain arsenic contents than the susceptible cultivars. With continuous flood management, higher soil arsenic drastically reduced the grain yield of susceptible cultivars. Yields

were reduced by more than 89 percent because of increased arsenic content in the grains. Intermittent flood water practice prevented some of the yield reduction. The arsenic buildup was found to be associated with iron redox (reduction-oxidation, a change in oxidation state) changes in the soil that were influenced by water management.

This study demonstrates that the selection of less arsenic-susceptible varieties and intermittent flood water practice could lower the arsenic accumulation in grains. It can also work against rice yield reduction.





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