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# Faculty Impact Statements 2009



May 2010

Research Series 580

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### **Faculty Impact Statements 2009**

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### Faculty Accomplishments Solve Problems and Create Opportunity

Faculty accomplishments that help solve problems and create opportunity are reported in this collection of 2009 impact statements. Some of these success stories represent many years of work; some are about programs just underway that hold the promise of future benefits. The simple format of stating an issue, the action taken to address the issue, and the impact or benefits of the work provides easy-to-read success stories.

These impact statements and those from recent years are on the Arkansas Agricultural Experiment Station Web site at:

http://arkansasagnews.uark.edu/394.htm

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### Competitive Agricultural Systems in a Global Economy

### **Animal Systems**

# Variation in quality characteristics of fresh pork bellies

#### Issue

Although there are apparent health benefits associated with the consumption of polyunsaturated fatty acids, increasing the polyunsaturation of pork fat leads to the development of soft fat. Thus, it is not surprising that feeding pigs polyunsaturated fat sources high in linoleic acid content will also cause soft fat and pork bellies. Soft fat and pork bellies cause carcass handling and fabrication difficulties; reduced bacon yields; fat-fat and lean-fat separation; unattractive, almost opaqueappearing bacon; package smearing; reduced shelf-life; and, more importantly, discrimination by domestic consumers and export partners. One of the problems facing the pork industry is how to measure fresh pork belly quality, and, in particular, variations in belly firmness. One method is measuring the iodine value of the belly fat, whereas others have implemented a number of subjective methods to measure firmness. Moreover, there remains a question of where on fresh bellies should firmness measures be collected. Therefore, a study was conducted to measure the intra-belly variation in compositional and mechanical firmness characteristics of fresh pork bellies.

#### Action

Lengths and widths of 24 fresh pork bellies were measured before bellies were divided into 3 rows (dorsal, central, and ventral) and 5 columns (designated 1, 2, 3, 4, and 5 from cranial to caudal), resulting in 15 equal-sized belly sections. Average thickness of the 4 sides of each section was recorded before 2 cores were removed and compressed 50% of the thickness between plates attached to an Instron Universal testing machine. Also, each section was punctured twice with a puncture bar attached to the Instron. Then, each section was knife-dissected into lean, fat and skin components to calculate the composition of each belly section. After weights of each component were recorded, the lean and fat portions were ground and subsequently freeze-dried for determination of fatty acid composition.

#### Impact

Previous research had indicated there was cranial-to-caudal variation in lean and fat composition in fresh pork bellies; however, results from this study also indicated there was a noticeable dorsal-to-ventral variation in not only composition, but also in mechanical firmness measures. Moreover, there appears to be an obvious firmness "grid," with the dorsal row being the firmest and, within the ventral row, columns 4 and 5 were the softest. Conversely, the dorsal row had the highest iodine values, indicating the greatest proportion of polyunsaturated fatty acids, whereas the ventral row, columns 4 and 5, as well as the central row, column 5, produced the lowest iodine values (least polyunsaturated). Results of this trial will assist today's pork processors by: 1) providing an objective measure of fresh belly firmness instead of the subjective methods currently in use; and 2) provide information on possible locations to measure belly composition and/or firmness. Moreover, these results could lead to the development of alternate belly fabrication methods to elicit greater value and enhance bacon quality.

#### Contacts

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#### Funding

University of Arkansas Division of Agriculture University of Arkansas Honors College Grant

#### Utilizing no-till production of small grain pasture to expand marketing alternatives for Arkansas cattle and crop producers

#### Issue

Both livestock and grain producers have been hit with extreme volatility in weather and costs of production and commodity prices, resulting in low yields and high costs of production with low returns on investment. This is occurring at a time of increasing pressure to reduce the environmental impact of production systems. A team of scientists from the University of Arkansas Division of Agriculture departments of animal science; crops soils and environmental sciences; and agricultural economics and agribusiness was formed to investigate differing production systems for small grain pasture to expand marketing alternatives. The objectives of the team's activities include: 1) Improve environmental quality by reducing soil erosion and increasing carbon sequestration with the use of minimum-till or no-till systems; 2) Increase sustainability of family farms by reducing input costs and providing viable alternatives to 'standard' cropping programs; 3) Minimize the risk from unpredictable weather extremes; and 4) Provide alternative marketing options for small cow-calf producers through the use of small grains for retained ownership of calves or row-crop producers by grazing of small grain pasture prior to harvest.

#### Action

The development of the small grains production systems

research and demonstration initiative involved a multi-disciplinary, multi-institutional scope with a producer and allied industry working group, and county agents working with local producers conducting field trials. The multi-disciplinary team included animal scientists, agronomists, and economists working collaboratively to study the impact of tillage systems, grazing, and economic outcomes. At the Livestock and Forestry Research Station, near Batesville, cattle grazed wheat established by no-till, clean-tillage, or minimal tillage methods, soil nutrients, forage production, animal production and system costs and returns were monitored. In addition, levee borders were created in three paddocks (one for each tillage system) and the paddocks were individually equipped with autosamplers to collect runoff following rainfall events to determine the amount of nutrients leaving each system. The on-farm projects examined grain yield potential of wheat grazed in Arkansas. County agents utilized wire panel restriction cages in grazed wheat fields to mimic calf removal at different morphological stages. These projects provided insight into typical production management (such as stocking rates, establishment methods, grazing initiation and termination, and fertility management) of small grains for developing calves beyond weaning. The on-farm projects also examined the impact of wheat grazing and harvest date on wheat harvested as a stored forage crop instead of a grain crop.

#### Impact

In most years animal performance did not differ between conventionally and no-till established fields, with one notable exception. When fall rains were delayed and conventional fields were planted into a dry seedbed, emergence and fall forage production was reduced by conventional tillage compared to no-till, reducing animal performance. Increased water retention with no-till establishment comes into play as a probable cause. Net returns in the current economic environment are \$117, \$202, and \$235/acre, respectively for winter pastures established by conventional tillage, reduced tillage, or no-till. Conventional tillage increases the amount of runoff from an artificial rainfall event by 3.8 times compared to no till, triples the NH3-N in water running off the pastures, and increases the concentration of phosphorus in the runoff water by 150%. In 2004-05, no-till was \$31.50/acre less expensive than conventional till and was more productive than conventional and minimum till, so no till produced \$94.70 and \$24.10/acre more profit than conventional and minimum till, respectively. Recent increases in fuel and machinery costs will result in these improvements in profitability becoming greater. Research results indicate an Arkansas beef producer with a 50-cow herd can increase whole farm profitability by \$9,900 to \$11,800/year through retained ownership of fall weaned calves using these techniques.

#### Contact

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#### Funding

USDA NRI Managed Ecosystems program grant number 2005-35101-15344; University of Arkansas Division of Agriculture

#### Understanding the cellular basis of feed efficiency

#### Issue

As much as 60 to 70% of the cost of raising an animal to market weight is attributed to feed. With continued price pressure on grains due to increased global demand including mandated ethanol production policies, feed efficiency (FE, the ability of animals to convert feed into meat, egg and milk) remains a very important genetic trait in poultry and livestock. Understanding the biochemical and physiological mechanisms that control feed intake and energy metabolism will facilitate discovery of the underlying genetic basis for feed efficiency that can in turn point toward potential biomarkers for genetic selection.

#### Action

Research has provided evidence of a strong link between mitochondrial function and feed efficiency in poultry and livestock. Based on a considerable body of research, investigations of global gene expression using some of the latest microarray, bioinformatics, and analytic software could help point toward fruitful areas to look for potential biomarkers that could aid in the selection of genetic stock with superior feed efficiency.

#### Impact

Continuing to make strides in improving feed efficiency in breeding stock remains a very important part in maintaining viable and sustainable poultry and livestock industries in the United States.

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#### Funding

University of Arkansas Division of Agriculture

#### Effects of heat shock protein-70 gene and forage system on milk yield and composition of beef cattle

#### Issue

Forage selection is one of the most essential aspects to being a productive cattleman. Due to the hardy nature of fescue it is often the forage of choice for most cattle producers in Arkansas. However, the negative consequences of fescue toxicity can be costly due to decrease in production. The objective of this study was to determine the influence the heat shock protein-70 haplotype and forage type (bermudagrass or endophyte-infected tall fescue) had on milk yield and composition of beef cows.

#### Action

Research animals were part of the breeding program at

the USDA-ARS, Dale Bumpers Small Farms Research Center (DBSFRC) near Booneville, Ark. for a seven year period, 1991 through 1997. Blood and milk samples were collected from 117 cows representing Angus, Brahman, and the reciprocal crosses of these two breeds, and three haplotypes. The cows were divided into pastures of either bermudagrass or endophyteinfected tall fescue to graze between May and September each year. Our data shows that an interaction between haplotype and forage causes the average milk yield for all three haplotypes to be significantly lower for cows grazing endophyteinfected tall fescue compared to cows grazing bermudagrass.

#### Impact

Results of this study suggest the need for an improvement in adapting genotypes to forage environments. An improvement in the genotype and forage interaction has the potential to improve production quality and cut the cost associated with fescue toxicity. A ten percent improvement in preventing fescue toxicity could save the U.S. beef cattle industry over \$60 million annually.

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#### Funding

University of Arkansas Division of Agriculture USDA/ARS

#### Assessment of prolactin promoter polymorphisms (SNP) as a genetic marker for resistance to internal parasites in Angus cattle

#### Issue

The environment in Arkansas is ideal for the support of internal parasites in cattle. It is estimated that the economic detriment in Arkansas cattle due to internal parasites ranges from \$25 to \$200/head. This includes losses in cattle performance and the cost of providing anthelmintic treatment. Overuse and continued utilization of some of the available anthelmintic products has led to development of resistance in parasites. It has also been reported that residues of anthelmintic chemicals have been found in food and the environment indicating a need for methods of non-chemical parasite control. This might involve a compromise between performances in productivity traits and reduced chemical control. Research is needed to identify means of non-chemical control. Research is needed to evaluate genetic resistance - perhaps the ultimate in sustainable parasite control. In conventional breeding programs, phenotypic selection for resistance could only be determined through exposure of the animal to internal parasites. The use of genetic markers for this traits could be useful in artificial selection.

#### Action

Spring born purebred Angus calves (n = 40) were used to determine the relationship between single nucleotide polymorphisms (SNP) and fecal egg counts of internal parasites. Calves were fecal sampled at weaning. All calves were treated with anthelmintic (fenbendazole, 10 mg/kg BW) at weaning. Genomic DNA was prepared from white blood cells and calves genotyped using previously published primers for the bovine prolactin promoter.

#### Impact

This study could result in a change in fundamental approaches to artificial selection in beef cattle. Prolactin genotype was related (P < 0.05) to strongyle egg counts at weaning (355 vs 149, and 167 eggs per gram; respectively for CC, CT, and TT). In addition, CC calves had higher (P < 0.05) strongyle egg counts at d 156 post treatment when compared with other calves (34 vs 13, and 14 eggs per gram). These preliminary results suggest that susceptibility to natural infection with parasites may be associated with elements of the prolactin gene. Consequently, considering the annual Arkansas cow herd is about 990,000 cows and 750,000 calves and the cost of parasite treatment is \$20/head, a 10% increase in the number of resistant animals could result in a \$3,680,000 return to producers.

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#### Funding

University of Arkansas Division of Agriculture

# Effects of breed and diet on beef quality characteristics

#### Issue

Cattle producers in tropical climates typically struggle with performance due to heat tolerance and insect and or parasite resistance. It has been proven that *bos indicus* cattle furnish more resistance and strength in these areas and are more adaptable than *bos tarus* breeds to such climatic environments. However, unlike their counterpart's, *bos indicus* are inferior in carcass traits offering decreased tenderness and loin eye areas collectively. Research is needed to determine if other breeds offer the genetic ability to not only persist in tropical conditions but also hold the capability of yielding superior quality carcasses .

#### Action

Conventional vs. forage-fed/grain finished systems were utilized to obtain an end product from 62 head, including 14 head of purebred Brangus, with the remainder consisting of five sire breeds Bosmara, Charolias, Gelbvieh, Hereford and Romosinuano. The longissimus muscle was collected from each carcass and sensory characteristics along with genetic grandsire and sire effects were evaluated.

#### Impact

This evaluation could change tropical production of beef cattle, offering a greater quality in carcass attributes. Grandsire breed and feed type interacted (P < 0.05) to affected myofibrillar tenderness (MYO), overall tenderness (OT), beef flavor (BF), and off flavor (OF) sensory traits. Evaluated connective tissue (CON) was impacted (P < 0.05) by grandsire breed. The ranking for connective tissue from most to least was Romosinuano (6.21)> Charolais (6.23)> Gelbvieh (6.43)>Bonsmara (6.51)> Brangus (6.53). Additionally, a grandsire breed and sex of animal interaction (P < 0.05) influenced MYO and OT sensory characteristics.

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#### Funding

University of Arkansas Division of Agriculture USDA/ARS

#### Cost savings and safety benefits with longer withdrawal period from anticoccidial drugs in poultry

#### Issue

Coccidiosis is a widespread disease of poultry caused by protozoan parasites of the genus *Eimeria*. Currently coccidiosis is controlled by preventative medication; in the broiler industry approximately 90% of farms utilize an anticoccidial drug in one of the feeds provided to growing birds. This procedure is expensive, especially in older stock that consumes the greatest quantity of feed. In recent years, concerns have been expressed regarding the use of drugs in this manner. Thus reduction in drug use, particularly in the weeks before slaughter will serve to reduce costs and drug usage. These objectives would be served if it was possible to increase significantly the period of withdrawal of medication without compromising coccidiosis control prior to commercial processing. Experiments at the University of Arkansas were designed to investigate this possibility.

#### Action

Experiments were conducted in floor-pens at the University of Arkansas Division of Agriculture poultry farm and under commercial conditions at the Division's commercial broiler research farm (Savoy). The acquisition of natural immunity to pathogenic species that cause coccidiosis was investigated in birds given typical drug programs used by the broiler industry. Results showed that in broilers reared to seven and eight weeks of age drugs could be safely removed from the feed at five weeks of age. Such birds showed that they had acquired significant protection against coccidiosis when challenged with the parasites.

#### Impact

A large local broiler company has estimated that cost sav-

ings following adoption of longer withdrawal periods in their complexes throughout the nation has been approximately \$9 million per annum. Furthermore, the increased withdrawal periods has further reduced the likelihood of violative residues being detected in poultry meat. Until alternatives to medication become cost effective and practical, such procedures will contribute to the protection of birds against the most widespread disease of poultry, reduce costs of production, and help provide a safe product for human consumption.

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#### Funding

University of Arkansas Division of Agriculture

#### Impact of fall or spring calving on fescue toxicosis

#### Issue

Tall fescue toxicosis costs U.S. livestock producers nearly \$1 billion annually in reduced weight, immune function, and reproduction. Recently, non-toxic, 'novel' endophytes (NE+) were incorporated into tall fescue and enhanced persistence of tall fescue without reducing cattle performance, but adoption of this technology has been slow. Our goal in this project is to determine the extent NE+ technology may mitigate the negative impacts of fescue toxicosis and thereby improve economic stability of cow/calf producers in the tall fescue region.

#### Action

Both spring and fall-calving cows grazed either toxic tall fescue (E+) or a combination of 25% NE+ and 75% E+. Additionally, spring-calving cows grazed 100% NE+ to serve as a positive control. Cows grazing pastures with 25% NE+ were moved to NE+ for 2 months in the spring and 1 month in the fall during periods when E+ appeared to exert the greatest negative impact on cattle. This equated to each group being moved to NE+ for 1 month prior to breeding and weaning.

#### Impact

Fall-calving cows appeared to tolerate E+ to a greater extent than spring-calving cows as shown by greater cow body weight and condition scores at breeding, a 44% greater calving rate, and 48 lb greater actual weaning weight compared with spring-calving cows. Using Arkansas state average calf prices (weight adjusted) on the actual calf weaning date, the sale value for fall-born calves was \$83 greater per calf sold and \$182 per cow exposed than that of spring-born calves. Replacing 25% of the E+ pasture area with NE+ resulted in 70% greater calving rates by spring-calving cows, and 11 lb heavier calves that were worth \$8.62 more at weaning than cows that only had access to E+ throughout the year. When adjusted for calving rates, spring-calving cows given limited access to NE+ produced 170 lb more calf weaning weight worth \$165 more that spring-calving cows with access to only E+. Replacing all of the E+ pasture with NE+ for spring-calving cows resulted in a 9% greater calving rate than those with 25% NE+ pasture and 85% greater calving rate than those cows grazing all E+. Cows on all

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NE+ weaned 90 and 82 lb heavier calves than spring-calving cows with 25% NE+ or all E+, respectively, resulting in \$53 greater calf value, but conversion of all E+ acres to NE+ is not feasible in most situations because of expense and topography. Furthermore, when compared with fall-calving cows, springcalving cows with year-round access to NE+ weaned calves that were 24 and 53 lb heavier than fall-calving cows with 25% NE+ or all E+, respectively, but the value of those calves was \$38 and \$22 below the value of fall-born calves weaned from 25% NE+ or all E+, respectively. Therefore, based on this information along with previous research at the same location, fall-calving cows appear to be able to contend with E+ better than spring calving cows, resulting in greater calving rates and heavier calves sold on a seasonally higher market, resulting in greater calf value, particularly when expressed as a percentage of the total number of cows exposed for breeding. Converting E+ pastures to NE+ may provide substantial production benefits for spring-calving cows, but may not be necessary or economically viable if fall calving is an option for producers.

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#### Funding

USDA - National Research Initiatives Competitive Grants Program CSREES Award No. 2006-55618-17114, USDA/ARS Cooperative Agreement with Dale Bumpers Small and Family Farms Center, and University of Arkansas Division of Agriculture

#### Endophyte effect negligible in postweaning performance of calves

#### Issue

Cattle buyers throughout the mid-south and southeastern U.S. pay less for calves weaned from toxic, endophyte-infected tall fescue (E+) because of perceived higher incidence of sickness and lower post-weaning performance. Measures taken to reduce the pre-weaning impacts of grazing E+ should therefore impact the value of these calves and improve profitability for cow-calf producers.

#### Action

Gelbvieh  $\times$  Angus calves born during both fall and spring calving seasons were weaned from grazing systems using all E+

or a combination of 25% non-toxic, novel-endophyte infected tall fescue (NE+) and 75% E+. Additionally, spring-born calves weaned from all NE+ served as a positive control. Calves grazing pastures with 25% NE+ were moved to NE+ for 1 month prior to weaning to allow those calves a chance to clear E+ toxins from their bodies prior to the high-stress weaning period. We have completed 2 years of post-weaning observations in which both steers and heifers were backgrounded on winter annuals (spring-born) or bermudagrass (fall-born) following weaning. Heifers were mated to determine subsequent calving rates and steers were finished in a feedlot facility.

#### Impact

Steers and heifers responded differently to the different tall fescue management systems. Fall-born steers weighed 65 lb more at weaning than spring-born steers, but spring-born steers weighed 186 lb more at shipping, reflecting differences in the different backgrounding systems that were available. Fall-born steers had greater total gain, but slower daily gains during the feedlot period. Carcass weights were similar between calving seasons. A higher percentage of fall-born steers graded choice than of spring-born steers. Replacing 25% of the pre-weaning E+ pasture with NE+ increased weaning weights of steers by 33 lb but had little impact on other post-weaning measurements. Fall-born heifers were only 24 lb heavier at weaning than spring-born heifers, but spring-born heifers were 100 lb heavier at breeding than fall-born heifers, again reflecting differences in available backgrounding systems for these heifers. Replacing 25% of the E+ acres with NE+ resulted in a 16 lb advantage in heifer weaning weight but the weight differential at breeding was only 7 lb. Entire replacement of E+ with NE+ for spring-calving cows increased the weaning weights of steers by 141 or 102 lb compared with their counterparts weaned from 25% NE+ or all E+, respectively. Although some compensatory gain appeared to happen during the backgrounding phase, final feedlot weights were 115 and 123 lb heavier from calves weaned from all NE+ vs. those weaned from 25% NE+ and all E+, respectively. Therefore, methods used to alter production of calves weaned from E+ pastures, such as altering calving season and partially replacing E+ pastures with NE+ may have an impact on weaning weights, but the benefits of these practices beyond weaning were negligible. Post-weaning performance by calves weaned from E+ pastures was similar to that of calves weaned from other systems, indicating that price discounts for calves weaned from E+ pastures is not warranted.

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#### Funding

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#### Optimum nutrition programs increase breeder hen fertility, hatching egg production, and decrease feed costs per hatching egg

#### Issue

A major limiting factor in the continuing development and growth of the poultry industry in Arkansas and the nation is the production of adequate hatching eggs and quality broiler chicks necessary to supply the industry. A key problem associated with the feeding and management of breeder strains producing ultra high yield progeny is a significant reduction in fertile hatching egg production, which has increased the feed costs per hatched chick. Dietary programs have been shown to have a direct effect on male fertility and hatching egg production but limited work on female fertility has been conducted. Key factors that may affect female fertility during a production period may be weight, body composition, and age. Dietary programs that provide optimum egg production are utilized for breeder hens because there is a lack of information suggesting different requirements for fertility.

#### Action

Researchers at the University of Arkansas recently conducted a feeding study to determine the requirements for broiler breeders for crude protein and amino acids for maintenance and production. The breeder pullets were individually housed in temperature controlled housing and fed synthetic diets to determine amino acid requirements for maintenance and fed semi-purified diets to determine production requirements. Breeder performance consisting of percent mortality, hatching egg production, fertility, body weight gain, feed conversion, and egg weights were determined with these production studies. Breeders were showed to require diets containing significantly less crude protein for production and fertility than presently being fed by the industry. Breeders were shown to require 13% crude protein containing ideal amino acid levels providing approximately 20 g per day for optimum production and fertility. The industry normally feeds a 16% breeder I diet and a 15.5% breeder II diet providing as much as 26 g of protein per day. The University of Arkansas research shows that breeders fed 16% protein diets had an average of 82% fertile hatching eggs compared to 90.5% fertile hatching eggs with a 13% protein diet. The digestible essential amino acid requirements determined for optimum breeder production was shown to be similar to previously suggested NRC(1994) requirements for arginine, methionine, phenylalanine and isoleucine but the research showed a higher requirement for digestible lysine.

#### Impact

A 13% crude protein level in breeder I and breeder II diets would decrease the feed costs approximately \$4/ton and 25 cents per breeder during the production period. The feed costs per dozen hatching eggs could be lowered by approximately 2 cents per dozen and the number of fertile hatching eggs increased eight percent from an average of 145 per breeder to 159 hatching eggs. The increased number of hatched chicks per breeder could increase by 10 increasing revenue by \$3 per breeder. The additional hatched chicks or hatching eggs are worth significantly more than just the increased monetary value of chicks. The continuing growth of the poultry industry in Arkansas and the U.S. will require that breeders increase the supply of quality chicks for grow-out to support the worldwide increasing demand for poultry meat. Breeders could be more selective in hatching eggs that are utilized for incubation and improve both chick quality and hatching percentage.

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#### Funding

Cobb-Vantress, Inc., Siloam Springs, Arkansas and the Arkansas Experiment Station. University of Arkansas Division of Agriculture

#### Effect of feed restriction programs on reproductive performance, efficiency, frame size, and uniformity in broiler breeder hens

#### Issue

Modern broilers have incredible genetic potential for growth. The broiler breeders that produce these birds have the same potential for growth but are feed restricted to prevent them from expressing it. This restriction is necessary to avoid the variety of problems that occur when broiler breeders are allowed to grow rapidly. Larger body weights and increased fat accumulation in broiler breeders have led to leg problems, early onset of sexual maturity, accelerated ovarian follicular development and the incidence of multiple hierarchies and multiple ovulations. The ultimate result is poor reproductive function. Feed restriction helps to alleviate the effects of these problems. Broiler breeder managers prefer skip-a-day feeding programs due to the benefits associated with uniformity. By feeding larger quantities of feed every second day, feed cleanup times are increased. This allows smaller, less aggressive birds' access to the feed for a longer time. Skip-a-day feeding requires that birds deposit nutrients into body reserves after a meal and then remobilize those nutrients during the off-feed day. This process may be inefficient.

#### Action

Three studies were conducted at the University of Arkansas Poultry Research Farm comparing everyday and skip-a-day feeding from 4 weeks of age to 5% production. Several parameters were measured including efficiency of feed utilization and performance parameters. The studies aim to determine the effects of different feeding programs on growth, body composition, egg production and various metabolic parameters. These included hepatic lipogenesis, lipogenic enzyme gene expression and metabolic hormone profiles. The results of these studies will help broiler breeder producers to determine the impact of different feeding programs on feed cost and costs per hatched chick or hatching egg. The metabolic analyses will help to explain the reasons for differences in efficiency of growth, production and body composition between the different feeding programs.

#### Impact

Understanding the economic impact of skip-a-day feeding will help producers to make more informed decisions about feeding strategies during rearing. The benefits of marginally improved uniformity associated with skip-a-day feeding may be outweighed by the significant improvements in efficiency due to everyday feeding. Studies showed repeatedly that everyday fed birds utilized feed between 7 and 10% more efficiently from 0 to 25 weeks of age than skip-a-day fed birds. Using average feed costs of \$191 per ton for starter, \$179 per ton for grower and \$187 per ton for breeder diets the feed savings by changing from skip-a-day to everyday feeding would be between 18 and 25 cents per bird. With approximately 75 million breeders in the United States, that would equate to a saving in feed costs between \$13.5 million to \$18.75 million. Apart from savings in feed costs, it was found that everyday fed birds consistently produced 4 more hatching eggs than skipa-day fed birds. Given a cost of \$1.60 per dozen hatching eggs, this equates to increased income of 53 cents per bird. With 75 million breeders nationally, the increased revenue from hatching eggs would equate to \$39.75 million. The total saving per breeder by using an everyday feeding system during the rearing period would be approximately 71 cents per breeder or \$53 million for the poultry industry on a national basis.

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#### Funding

Cobb-Vantress, Inc., Lonza Inc.; University of Arkansas Division of Agriculture

#### The interrelationship between genetic, immune, gender, and environmental factors in the Smyth line chicken

#### Issue

Diseases not caused by pathogens (chronic inflammatory diseases, cancer, autoimmune diseases, etc.) generally depend on a particular combination of genetic susceptibility and environmental factors that trigger the expression of the disease. While disorders of this nature are common in both production animals and humans, there are few model systems that provide opportunity to dissect the interrelationship between genetic susceptibility and environmental triggers. The Smyth line of chicken, which develops autoimmune vitiligo (pigmentation disorder) between 6 and 20 weeks of age, is a unique animal model to study the onset and progression of multifactorial diseases.

#### Action

Based on efforts by University of Arkansas scientists the ex-

pression of vitiligo in the Smyth line chicken has been shown to be strongly associated with exposure to live herpesvirus of turkey (HVT) at hatch. As part of a current research project, a system has been developed to reduce the spontaneous development of vitiligo in this line of chicken from 85-95% to 10% by not administering the live virus to chicks at hatch. With this large range of vitiligo incidence between HVT-negative and HVT-positive chicks this animal model provides opportunity to examine the interrelationship between an environmental trigger, genetic susceptibility and the autoimmune activities that lead to the loss of pigment cells. In an effort to examine the ability of other environmental factors to trigger expression of autoimmune vitiligo in HVT-negative Smyth line chickens, it was observed that a one-time administration of inflammatory agents into the target tissue (growing feather) did not reliably trigger vitiligo expression. Induction of oxidative stress in the feather, however, resulted in morphological alterations of melanocytes including retraction of dendrites and detachment from keratinocytes. These alterations were not observed in non-susceptible control lines of chickens. Moreover, this treatment resulted in enhanced production of oxidative radicals in feathers of Smyth line chickens compared to controls. As HVT translocates to the feather follicle epithelium, the current working hypothesis is that HVT the infection, either directly or indirectly (due to the antiviral immune activity), changes the pigment cells' local environment causing alterations in the pigment cells that make them visible to the immune system.

Knowledge gained from studying the interrelationship between genetic, immune, gender, and environmental factors in the Smyth line chicken will greatly contribute to our understanding of the etiology of chronic, progressive, immunemediated diseases in poultry and humans.

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#### Funding

Arkansas Biosciences Institute, University of Arkansas Division of Agriculture

# Effects of dried distillers' grains on performance of stocker cattle grazing bermudagrass

#### Issue

Arkansas has approximately 1.8 million cattle, with a total value over \$432 million; feed costs dramatically affect the prosperity of this enterprise. Ethanol production has had a considerable influence on the cattle industry, because expanding ethanol production removes corn from the cattle feed supply yet creates dried distillers' grains. During ethanol production, starch is removed from this corn and converted to alcohol leaving the remaining concentrated nutrients in dried distillers' grains. Dried distillers' grains are relatively high in crude protein, moderately high in energy due to their fat content,

high in digestible fiber, but low in starch. In typical Arkansas production systems, cattle obtain the bulk of their nutrients from forage, yet in order to meet nutritional requirements for maximal growth, it is sometimes necessary to supplement energy and/or protein. However, additions of high-starch supplements like corn may decrease forage intake and fiber digestion. Distillers' grains have the positive characteristic of providing a degradable non-starch carbohydrate, unfortunately they also have some potentially negative characteristics such as being high in sulfur (due to the use of sulfuric acid during fermentation) and being much greater in phosphorus than calcium (potentially resulting in a dietary calcium:phosphorus ratio of less than 1:1). Bermudagrass is a warm-season perennial grass prevalent in Arkansas; however, its high fiber content reduces forage intake limiting calf growth. Fortunately, calves grazing bermudagrass respond positively to supplemental energy. Multiple studies have examined supplementing dried distillers' grains for cattle grazing low- and moderate-quality forages, but research on cattle grazing bermudagrass and offered dried distillers' grains is limited. Thus, objectives of 2 experiments were to study the performance of stocker cattle grazing bermudagrass supplemented with dried distillers' grains: 1) as a substitute to corn or soybean hulls and 2) without or with limestone (4.3% of supplement) to result in a dietary calcium:phosphorus ratio of 2:1.

#### Action

In the 1st experiment (replicated over 2 years), 144 stocker calves were supplemented with corn, dried distillers' grains, or soybean hulls at 0.5% of their body weight while grazing bermudagrass. Cattle remained on pasture for 107-days in year 1 and 84-days in year 2. In the 2nd experiment (replicated over 2 years), 162 stocker calves were supplemented with dried distillers' grains without added limestone at 0.75% of their body weight or with added limestone at 0.78% of their body weight while grazing bermudagrass. Cattle remained on pasture for 140-days in year 1 and 98-days in year 2.

#### Impact

Corn, dried distillers' grains, or soybean hulls supported similar daily gains; in addition, distillers' grains with or without added limestone supported similar daily gains. Due to similar growth performance and no observations of negative consequences, the choice to use dried distillers' grains in a supplement for cattle grazing bermudagrass should be based on cost and availability of this co-product.

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#### Funding

University of Arkansas Division of Agriculture

# Impact of improvements at the beef research farm at Savoy

#### Issue

The number of university beef research farms is declining in the United States, and many that do remain are understaffed or underfunded to the extent that their capability of conducting research is severely hampered. This was happening to the University of Arkansas Division of Agriculture cow/calf research unit at Savoy. Several steps were needed to improve the land and part of the facilities, equipment, and cattle. Qualified personnel are a very important requirement to manage the pasture and hay crops, to care for the cattle, and to ensure that accurate records are maintained. These elements are necessary to attract external funding for research and to meet the important research needs of Arkansas producers.

#### Action

Professional assistance was utilized within the Division of Agriculture to set priorities and obtain technical information. The first priority set was to improve the grass production to provide more pasture and hay for the cattle. This was done by spraying weeds and small brushy plants to reduce competition for soil nutrients and moisture during the growing season. Both fescue and bermudagrass fields were available and decisions were made regarding which crop was best suited for each area of the farm. When possible, fertilizer was applied to hay fields and lime was spread according to soil test recommendations. A 4-week rotation system was established with 10 pastures that could provide adequate feed and water for up to eight herds of 20 to 30 cows each; thereby providing a rest period for one pasture during each rotational period. Simultaneously, records were used to select animals that could perform well in the circumstances of an upland farm with limited funding for supplemental feeds. Selection pressure was applied using weaning weights of calves, mature weights of cows, and ages of cows. Bulls and semen were purchased that were projected to meet the goals set for size of cows, weaning weights of calves, and quality of calves. A computer program was purchased to keep and access records efficiently. Finally, requests were made for equipment and facilities, and priorities were established to fit supplemental funding that became available.

#### Impact

Grass production during both the warm and cool seasons was improved, including two new pastures that were developed by eliminating tall weeds and brush. Variable weather patterns affected individual seasons, but there was enough grass produced to provide pasture and good-quality hay each winter. The rotational pasture system worked well. As a result weaning weights improved by about 50 pounds per calf. New equipment and facilities were realized as funding became available. A 3-yr study was initiated with a commercial grant that involved the cow/calf unit, the backgrounding unit, and the finishing unit of Oklahoma State University. A separate 100-cow herd was established to study parasites with external funding. Interdisciplinary research was expanded to study the watershed in cooperation with personnel from other departments within the University.

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#### Funding

Funding was primarily from the University of Arkansas Division of Agriculture, although commercial grants funded individual research studies

# Host-virus interactions of respiratory virus infection in poultry

#### Issue

Endemic respiratory viral diseases of poultry continue to collectively cost poultry producers millions of dollars annually. Infectious laryngotracheitis (ILT) is an acute upper respiratory diseases caused by the infection of ILT virus (ILTV). In acute cases, there has been up to 70% mortality in infected chickens. Recent developments of functional genomic techniques, including massively parallel DNA sequencing and microarray analysis, enabled to analyze a variety of biological mechanisms simultaneously. The biological, physiological, immunological knowledge bases for host-pathogen interactions need to be established to develop an optimal control plan for animal protection.

#### Action

Using 454 FLX sequencing method, which is one of the massively parallel next generation sequencing methods, seven candidate ILTV encoding microRNAs, including two unique iltv-miR-I1-3p and iltv-miR-I7-3p, were identified and the expression of all ILTV microRNAs was confirmed by PCR assay. To better understand host-ILTV interactions at the host transcriptional level, a microarray analysis was performed using a 4 X 44K Agilent chicken custom oligo microarray. Hundreds of genes were highly variable in their expression during the time course of ILTV infection. The differential expression due to ILTV infection include genes responsible for immune responses (cytokines, chemokines, MHC, and NF-KB), cell cycle regulation (cyclin B2, CDK1, and CKI3), matrix metalloproteinases (MMPs) and cellular metabolism. A bioinformatics tool (Ingenuity Pathway Analysis) was used to analyze gene functionalities in the scope of biological functions and pathways on the differentially expressed genes in ILTV infection, resulting in that genes were classified into a number of functional groups including cancer, genetic disorder, cellular growth and proliferation, and cell death.

#### Impact

Microarray analysis provided comprehensive knowledge from global gene expression, functionalities, and biological networks among differentially expressed genes in the host response to ILTV infections. And, microRNA species expressed from ILTV are expected to function critically in host-virus interactions by regulating gene expression on both host and viral genes. Knowledge in host-virus interactions will be utilized to develop a better control strategy for infectious viral disease in poultry. Moreover, technologies used in these studies are applicable to a variety of biological research areas in poultry sciences.

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#### Funding

Arkansas Bioscience Institute; University of Arkansas Division of Agriculture

# Energy supplement impact on reproductive efficiency

#### Issue

The early growth of cool season forages is typically very high in protein. Research in dairy cattle has shown that forages which are excessively high in nitrogen (crude protein) content can lead to high levels of urea in the blood of cows. The high blood urea nitrogen (BUN) has been shown to decrease pregnancy rates in cows. There is therefore the potential for early growth cool season forages to contribute to reduced pregnancy rates in beef cattle. Additional energy added to the diet of cows consuming high protein forages may improve the utilization of nitrogen and reduce BUN.

#### Action

A series of 3 trials were conducted to evaluate the effects of adding energy supplements to the diets of heifers grazing ryegrass pastures in the early spring. Heifers receive either no supplement, 30 days of supplement at 60 days prior to breeding, or 30 days of supplement starting at 30 days prior to calving.

#### Impact

We have found that serum urea nitrogen is elevated to concentrations that could be detrimental in the very early parts of the spring growing season in cattle grazing the early growth of ryegrass, but that these levels declined before animals were exposed to AI and did not affect conception rates to AI. The complete data from this study are being summarized for publication.

Reproductive efficiency is one of the most important economic factors involved in beef cattle production. Methods to improve reproductive efficiency by improving the utilization of nitrogen of cool season forages would be of great economic benefit to Arkansas beef producers.

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#### Funding

University of Arkansas Division of Agriculture

# Hormone gene promoter region isolated in bovine genome

#### Issue

The genome has been sequenced for several species, including the bovine, and it is possible to locate and identify specific genes. Once genes are identified and their sequences determined, the next step in understanding how specific genes function is to determine specifically how genes are turned on and turned off.

#### Action

We have succeeded in isolating the promoter (control) region of the bovine beta follicle stimulating hormone gene from bovine genomic DNA. We are using DNA sequence data from these promoter regions to identify single nucleotide polymorphisms that may be related to reproductive function as well as other functions.

#### Impact

FSH is one of the two gonadotropins that are essential for successful reproduction in all animals. An understanding of the control of FSH production at the level of the gene will enable a better understanding of the control of reproductive function in animals and provide the potential for the development of tools or methods to control or enhancement reproduction in domestic animals. In addition, a basic understanding of how gene promoter sequences function in the control of gene expression may have application to the control of other genes and in the production of transgenic animals. In addition, the identification of SNPs in the promoter region of the FSH gene may yield genetic markers that can be used to select animals with superior reproductive function.

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#### Funding

University of Arkansas Division of Agriculture

# Gene polymorphisms may lead to markers for ascites resistance

#### Issue

Ascites is a genetically linked condition in broilers that results in pulmonary hypertension and results in the accumulation of fluid in the thoracic cavity. The condition is prevalent in lines of broilers that have been heavily selected for growth and performance and contributes significantly to production losses in the broiler industry.

#### Action

We initiated studies in ascites resistant and ascites susceptible broiler lines to investigate the occurrence of gene polymorphisms in the promoter regions of genes that are related to inflammation and blood flow in the pulmonary system of broiler. These studies were conducted to find genetic markers that might be useful in the selection of birds that are resistant to ascites.

#### Impact

We have found two polymorphisms in one gene, five polymorphisms in a second gene and two polymorphisms in a third gene that occur with much different frequencies in resistant broiler lines than in the susceptible line. The collection of additional data has verified these results for at least one of these genes. These markers could be very important in developing selection tools to help select broiler lines that are naturally resistant to ascites. Markers would enable breeders to more easily select breeder animals or identify susceptible lines so that management practices can be implemented to minimize the occurrence of ascites in broilers.

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University of Arkansas Division of Agriculture

# Researchers seek genetic marker for bovine respiratory disease

#### Issue

Bovine respiratory disease (BRD) is widely regarded as the most costly disease to affect the beef cattle industry. The disease affects primarily stocker and feedlot calves and causes mortality and high morbidity. Treatment requires the extensive use of antibiotics and animals frequently perform poorly even if they recover after treatment.

#### Action

We have begun studies of several genes involved in the natural immune response of beef calves in order to find genetic markers that can be used to determine if calves are more or less resistant to BRD. We have evaluated potential markers in two of three genes being evaluated and are continuing to collect data from additional animals for further evaluation.

#### Impact

The ability to identify animals that are naturally resistant to BRD will potentially enable the selection of animal lines more resistant to BRD. In addition, from an animal management standpoint, the ability to identify susceptible and resistant animals would allow the more effective and judicious use of antibiotics and other treatment therapies in animals that are identified as susceptible.

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#### Funding

University of Arkansas Division of Agriculture

# DNA fingerprint used to identify larval states in cattle parasites

#### Issue

The correct identification of the organisms that infect cattle and an accurate count of those organisms that resist treatment is an important step in the evaluation of the effectiveness of internal parasite control programs in cattle. However, the accurate identification of the larval forms of parasites that infect cattle is difficult and time consuming due to the very small morphological differences in the larvae of different species when examined under the microscope.

#### Action

We are using a technique developed by USDA scientists to identify the larval stages of major cattle parasites through the extraction of parasite DNA and the identification of sequences that are unique to specific organisms. If this method proves to be reliable and repeatable, we intend to extend this technique to enable determination of the relative amounts of DNA from each organism so that this test can be used as a highly accurate and efficient method for the study parasite resistance and the effectiveness of various anthelmintic treatments. We are also evaluating this technique in goats.

#### Impact

The availability of a technique to accurately and rapidly determine the quantity and type of helminthes present in cattle would be beneficial in the development of new anthelmintic drugs as well as in the accurate identification of resistant organisms that may pose future problems for producers.

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#### Funding

Hartz Mountain Research Fund and University of Arkansas Division of Agriculture

# Sexual behavior, aggressive behavior and stress in broiler breeders

#### Issue

Broiler breeders, the birds responsible for producing chicks that supply supermarkets and restaurants with poultry meat, mate naturally in commercial facilities. Importantly, eggs produced by hens need to be fertilized and after incubation for 21 days, hatch quality chicks throughout their lifetime. With natural mating, it is equally important that males take the appropriate time for courtship behavior which usually comprises a waltz-like behavior resulting in a half circle movement around a hen with one wing outspread having the tips of the feathers nearly touching the ground. Interestingly, this same waltz-like behavioral sequence is also used by roosters when they face-off prior to an aggressive encounter. Recently the broiler industry became concerned with increased aggression displayed by males of some broiler lines toward females during sexual behavior. The reason for this abnormal behavioral change is currently unknown. We therefore began a series of experiments to examine the brains of roosters to determine if specific neural structures in the brain may be linked to aggressive versus sexual behavior.

#### Action

We video-recorded roosters that completed appropriate sexual behavior including waltzing. In contrast, we also recorded male-male interactions that resulted in aggressive behavior. Thereafter we examined the brains of roosters employing an assay called cfos immunostaining, that shows activation of selective neurons following performance of a behavioral sequence. Of interest is that one specific brain nucleus was activated solely during sexual behavior. Several specific brain nuclei were activated during aggression. In particular, one brain structure showed high levels of activation following male-male encounters and that brain nucleus located in the hypothalamus, a neural region directly above the pituitary gland, contained the two types of neurons comprising the classical hypothalamo-pituitary-adrenal axis or HPA axis. This stress pathway or HPA axis results in the pituitary releasing a hormone followed by the adrenal gland releasing the stress hormone cortisol (in humans) or corticosterone (in rats and chickens) into the circulating bloodstream.

#### Impact

Our goal is to examine specific neural pathways in the avian brain that control either a behavior or a physiological function. The differential activation of brain structures for sexual behavior and those linked to aggression gives us a template for linking some of the sites together in a functional pathway. It means developing a set of techniques to determine if one identified neural structure projects to a candidate structure. We are currently establishing the tract-tracing procedures in our laboratory. Importantly, once a neural pathway is uncovered, one can then determine its major chemical (neuropeptide or neurohormone) released which may be a critical marker that poultry geneticists can utilize to help select for that particular behavioral sequence in future genetic lines of poultry.

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#### Funding

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# Robust method for specific amplification of multiple target sequences

#### Issue

For many applications of genetic analysis, including molecular typing of bacterial strains and SNP (single nucleotide polymorphism) genotyping, it is becoming increasingly important to retrieve multiple target gene sequences specifically and reproducibly with minimum contamination by unwanted DNA sequences. For example, rapid development of DNA sequencing technologies in recent years, collectively called "next-generation sequencing technologies" enabled sequencing of an enormous amount of DNA without a cloning step. Therefore, in order to maximize the utility of sequence information obtained by next-generation sequencing methods, it is essential to capture only the sequences that are informative for a particular analysis to establish efficient and cost-effective genetic analysis. Multiplex PCR involving many pairs of primers has limited utility, because it tends to amplify non-specific sequences as the number of target increases beyond 10 -20. Currently, there are two different approaches to capture multiple target sequences from complex genomes, one based on hybridization to capturing sequences and the other one using PCR-based amplification. However, all of the currently methods suffer from their inability to capture all of the intended targets or capturing non-target sequences.

#### Action

We developed a very efficient PCR amplification protocol to amplify many (potentially hundreds) target sequences in the genome. To overcome the limitations of the current methods, we employed a novel strategy of using two hairpin-linkers specifically designed for each target sequence. We optimized the protocol to simplify the procedure, while increasing reproducibility and efficiency. To evaluate the utility of this novel amplification method, we applied this method to establish an advanced molecular typing method for *Salmonella*. We found this method can readily amplify 21 target gene sequences of 200~300 bp long simultaneously from each of 41 different *Salmonella* strains. We are in the process of sequencing the entire amplified DNA in one sequencing run using 454 pyrosequencing method using a barcoding system to allow identification of the sequences obtained from each strain.

#### Impact

Strain typing methods are an important tool to investigate transmission, ecology and epidemiology of pathogenic bacteria. The major criteria used to evaluate the performance of various strain typing method include discriminatory capability, reproducibility, and labor and time required for the procedure. Currently, the most advanced typing methods are PFGE (pulsed field gel electrophoresis) and MLST (multilocus sequence typing). However, even these methods have their own shortcomings. As one application of our multiplex target amplification protocol, our improved strain typing method has a high potential to overcome the limitations of other methods, enabling robust and rapid typing of many sample strains. This amplification method can also find application for very efficient and comprehensive discovery of SNP in chickens and human associated with important genetic traits when used in conjunction with next-generation sequencing.

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#### Funding

USDA Food Safety Consortium University of Arkansas Division of Agriculture

#### Darkling beetle management in poultry houses

#### Issue

Arkansas has approximately 7,000 poultry producers and ranks number 2 in the USA for broiler production. Poultry accounts for almost 40% of Arkansas agriculture. One insect pest, the darkling beetle, Alphitobius diaperinus, is a serious problem for poultry producers. Adult and larval beetles are potential reservoirs of poultry pathogens, the larvae destroy insulation in poultry houses, and adults are a nuisance as they migrate to nearby residential housing during litter clean-out. Because of these issues, darkling beetles are a major pest in Arkansas production. The insecticide cyfluthrin had been the insecticide of choice for Arkansas poultry producers for many years, especially as other insecticides were no longer labeled for use in poultry houses. Recently, extension agents and poultry producers have reported reduced efficacy of cyfluthrin against darkling beetles, as resistance has developed. Loss of labeled insecticides and development of insecticide resistance by darkling beetles reduce the options to protect against this beetle. Additional management options are necessary to effectively manage darkling beetles.

#### Action

We developed a project in collaboration with the University of Arkansas Division of Agriculture Applied Broiler Facility, Simmons, and Bayer Animal Health, to identify alternative insecticides for management of darkling beetles. Our results in Arkansas (as well as results from other states) demonstrated efficacy of imidacloprid to control darkling beetles. Our efficacy data, plus that from other states, resulted in labeling of imidacloprid. Continuing studies are assessing the efficacy of an additional insecticide combination that could prove useful in darkling beetle management.

#### Impact

Labeling of a new product, coupled with recommendations from the Cooperative Extension Service, provided the 7,000 poultry producers with an additional solution to use against darkling beetles. Because imidacloprid is in a different insecticide class, Arkansas poultry producers can add this insecticide to their rotation to reduce issues with insecticide resistance and manage darkling beetles.

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#### Funding

Bayer Animal Health

# Development of direct fed microbials for young pigs

#### Issue

The gastrointestinal tract of animals is the site of complex interactions between the host immune system and various dietary factors, their breakdown products, as well as microorganisms. Studies on colonization of the intestinal tract of gnotobiotic animals with either defined enteric bacteria or incompletely defined normal gut microflora have revealed that the microbial population drives gut immune system development. The "hygiene hypothesis," as an explanation for the development of allergy and asthma, suggests that insufficient immune stimulation as a result of modern sanitation practices within the developed world compared to undeveloped society may give rise to an underdeveloped immune system as a result of decreased microbial exposure. Modern swine production facilities, in which pigs are raised in indoor, confinement structures and sanitation is implemented for disease control, may be analogous to the relatively sterile environment of developed society, predisposing pigs to pathogenic infections at the gut mucosal level and systemically because of an inadequately developed immune system. The importance of colonization by commensal microbiota for the development of a functional gastrointestinal and immune system has been widely recognized and well documented in the scientific literature. Development of effective direct-fed microbials should capitalize on the succession process by identifying key members of the microbial community associated with desired functions and thereby dictate a portion of the microbiota to benefit health and production of livestock species.

#### Action

Two studies have been completed with a goal of developing an understanding of the interplay among the gut microbiota, immune system, and performance using pigs raised in on-site and off-site nursery systems and pigs farrowed in outdoor and indoor facilities as a model. In the first study, two swine herds located in Sheridan, Idaho and Springfield, Colo. with similar genetics (PIC C-22  $\times$  PIC 280) were used. Pigs from the Indiana facility were farrowed and reared by sows housed in conventional environmentally-controlled confinement swine facilities, whereas pigs from the Colorado facility were farrowed and reared by sows housed in an outdoor pasture system. A total of 252 pigs (126 from each location) were transported to the University of Arkansas Swine Research Nursery facility at weaning (19 d of age). Pigs from each location were housed in separate rooms with husbandry duties performed by separate personnel to prevent microbial exposure between treatment groups. In the second study, pigs from the University of Arkansas herd were reared after weaning in either on-site or off-site facilities. Individual pig performance and immune function was evaluated over a 6 week period. In addition, pigs were humanely euthanized and tissue samples from the jejunal region of the small intestine were obtained for further immune function analysis and to obtain bacterial DNA samples. The DNA was then amplified and analyzed with Terminal Restriction Fragment Length Polymorphism (T-RFLP) to generate

Terminal Restriction Fragment (TRF) data. The TRF data were correlated to characteristics of interest including performance and immune function. Strains of interest were identified from the correlations and a provisional patent application has been filed identifying the species (U.S. Provisional Patent Application 61/143,990 entitled "Lactic Acid Bacteria and their use in Swine Direct-Fed Microbials" filed on January 12, 2009. This understanding of differences in the succession of the establishment of the gastrointestinal microbial population has permitted selection of candidate bacteria for potential development of direct fed microbials for screening as potential targets for use in feeding programs designed to impact specific immune functions resulting in maximal performance in commercial swine production systems.

#### Impact

This research indicates that rearing environment during early immune system development influences the pig's immune system. The immune system of pigs farrowed in outdoor facilities compared to those farrowed indoors appeared to be less inclined to elicit an inflammatory immune response to challenges. Common management practices in modern swine production have likely altered the progression of immune system development, particularly as related to the exposure and colonization of the resident gastrointestinal microflora. The results of our studies support the idea that pigs raised in a less controlled environment (i.e. outdoors) have the potential to develop immunological responses that are more tolerant with less inflammatory responses to many of the challenges faced in modern swine production, and warrants further investigation into the specific mechanisms of immune tolerance induction as it relates to environmental and dietary management of young pigs, and the presence of a commensal microbial population in the gastrointestinal tract. The identification of specific gut microbiota associated with improved performance and enhanced immune system development outlined in a provisional patent filed by the University of Arkansas provides the necessary bacterial species to further investigate the relationship between the specific bacteria, immune system development and performance. This is consistent with the "hygiene hypothesis" which suggests that insufficient immune stimulation as a result of modern sanitation practices within the developed world compared to undeveloped society may give rise to an underdeveloped immune system in the human population and suggest that the pig may be an excellent model to study environmental impacts on the ontogeny of immune function.

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Private industry; Arkansas Biosciences Institute; University of Arkansas Division of Agriculture

#### Alternative model selection using forecast error variance decompositions in wholesale chicken markets

#### Issue

Although the vast majority of broiler meat is currently sold under contract to foodservice and further processors, the prices for these contracts are benchmarked, to a large extent, off of the wholesale prices. Therefore, it is essential for integrator firms (e.g. Tyson Foods, Conagra, Purdue, Pilgrims Pride, etc.) to accurately forecast chicken cut prices from one to nine months ahead. It is from such forecasts that forward contract prices for chicken cuts are established between integrator firms and buyers (retail grocery firms, restaurants, and fast food chains). Inaccurate forecasts lead to either lower volume sales or a reduction in potential profit margins.

#### Action

Researchers developed a forecasting model selection tool – using Sims-Bernanke Forecast Error Variance Decompositons generated from Directed Acyclic Graph-inspired structural Vector Autoregressive Models. This tool represents an alternative to Granger Causality, which has typically been used in forecast model specifications. The tool was successfully applied to forecast prices of wholesale chicken parts.

#### Impact

The research showed that if the poultry industry were to improve price forecasts with this approach, savings of between \$4.57 million and \$10.3 million could be attained. In fact, the tool has been used by a major poultry company to better forecast the prices of chicken parts.

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#### Effect of white striping on the histological and meat quality characteristics of broiler fillets

#### Issue

Poultry breast meat quality continues to be an important issue as the breast meat is the desired consumer portion of poultry meat. Broiler breast fillets are sometimes characterized grossly by white parallel striations in the direction of the muscle fibers, referred to as white striping. This white striping can vary in severity and can be easily seen in the muscle. However, the histological characteristics and the impact of this problem on meat quality are unknown.

#### Action

A study was conducted to evaluate the histological

characteristics of this white striping and its impact on meat quality characteristics. Breast fillets were collected from 1112 birds (59-63d) of different commercial high yielding strains processed over 3 days. According to the visual severity of white striping, the breast fillets were separated into three categories: 0 (normal), 1 (moderate striping) and 2 (severe striping). Samples were collected from each degree of white striping, immediately after slaughter, to prepare slides for histological studies. Ready-To-Cook (RTC) carcass weight, pH and color at 24h postmortem, dimensions of fillets (length, width, and height), cook loss, and Meullenet-Owens Razor Shear (MORS) energy values of the fillets were collected. Histological analysis showed a condition of myopathy with degenerative changes and an increase in collagen deposition. The percentage of samples showing 0, 1 and 2 degrees of white striping in males were approximately 37, 53 and 10%, respectively, whereas those of females were 53, 42 and 6%, respectively. Within each strain, more than 50% of birds had some degree of striping (1 or 2 category) with the exception of strain D which had 41%. Interestingly, 72% of strain C birds exhibited striping; strain C also had the highest RTC weight. RTC weight and most of the fillet dimensions were significantly higher for white striping samples compared to the normal ones. Muscle pH, color, cook loss and MORS energy (tenderness) were not significantly affected by the striping condition.

#### Impact

The results of this study suggest that the white striping condition is related to degenerative muscle fibers and an increase in collagen deposition. The condition is associated with heavier birds; therefore, males and the strains with the heavier body weights were affected to a greater degree. However, the results of this study suggest that meat quality of whole muscle products is not affected by the white striping observed in breast fillets.

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University of Arkansas Division of Agriculture

#### Impact of phase-feeding and strain on yield, fillet dimensions, and meat quality of broilers in small bird or big bird market programs

#### Issue

Meat and carcass quality are very important issues in the poultry industry. Specifically, tenderness of early-harvested broiler breast meat as well as product uniformity are primary concerns. Moreover, the industry is always interested in lowering production costs. Phase feeding is a regimen that has been shown to reduce production costs without negatively impacting growth performance or carcass yield. However, phase feeding research has been limited to a single strain of male broilers and further research is needed to evaluate its impact on various strains in straight run production systems. Therefore, the purpose of this study was to evaluate yield and meat quality of broilers from various genetic strains representing different growth patterns in small bird or big bird markets, and to determine the impact of phase feeding on these characteristics.

#### Action

Commercial broilers representing multiple genetic strains in industry were raised and processed at a common market age (40 or 60 d depending on market program) using standard commercial practices. Broilers were fed a diet consisting of a typical industry program or a phase feeding regimen. Broilers were processed and deboned at 2, 4 and 6 h postmortem. Fillets were subjected to footprint analysis, shear, muscle pH, color, drip loss, and cook loss analysis. In the small bird program, diet, strain and gender had little impact on fillet yield. Strain, gender, and debone hour had significant effect on fillet dimensions. Strain and PF treatment did not affect pH, color, cook loss or MORS. In the big bird program, there were no differences in tenderness due to strain at 2 h PM, but differences due to strain were observed at 4 and 6 h PM. There was some variation in color due to strain, but there was no difference in cook loss due to strain at any deboning time. Fillets of males had significantly higher MORS energy (tougher) when deboned at 2, 4, and 6 h PM than those of females. Phasefeeding had little impact on fillet yield or dimensions; however, uniformity was either maintained or improved the incorporation of PF regimen. Strain impacted fillet yield and fillet thickness. Fillet dimensions were affected by deboning time in each trial. Deboning at 2 or 4 h PM resulted in narrower fillets that were also thicker due to sarcomere shortening compared to fillets deboned at 6 h PM.

#### Impact

Phase-feeding does not adversely affect yield or meat quality of broilers in small bird or big bird programs regardless of strain. Deboning time, gender and strain can have impacts on meat quality (e.g., tenderness) in big bird programs. Pre-rigor deboning does impact fillet dimensions and the results suggest that the effect is more drastic in big bird programs.

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# Strategies for cost-effective clover establishment

#### Issue

Major obstacles for increased use of legumes on beef farms are cost of establishment and planting strategies that result in good long term persistence. The method of choice has been no-till planting of legumes, but costs are relatively high and canopy control of existing grass sward is necessary for over-seeding legumes successfully. With this study, we seek to develop cost-effective methods of legume establishment that are acceptable for area producers.

#### Action

We designed an experiment that determines the effects of no-till planting and broadcasting of legumes on seedling emergence and survival. Additionally, we tested the effects of grazing cattle on establishment success when canopy was grazed either before or after planting. In autumn of 2009, crimson and white clover were planted using a 7-foot no-till drill or were broadcast by hand at a high and low seeding rate. Plots were grazed either before or after seeding. This study will undergo an additional replication during the following year.

#### Impact

Preliminary results suggested that at a high seeding rate of both crimson and white clover, seedling emergence is most successful when a no-till drill is used. Under this scenario, the pasture canopy must be short to ensure most efficient use of expensive inputs. However, when seeds are broadcasted, then it may be advantageous to graze after planting to enhance seedsoil contact through cattle hoof action. This may be a long term strategy to establish small areas initially and expand to other areas of the farm during following years. Findings from our research are disseminated to producers through outreach activities, including on-farm demonstrations, field days, and in-service trainings for county agents. Widespread legume use by producers may lower nitrogen fertilizer costs associated with beef production.

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#### Funding

NRI/Agricultural Prosperity for Small and Medium Sized Farms; University of Arkansas Division of Agriculture

# Evaluation of annual and perennial legume persistence

#### Issue

With increasing nitrogen fertilizer costs, beef producers are forced to look for alternative N sources to provide their pastures with this plant nutrient. Our research aims at selecting appropriate annual and perennial legume species that could be included into beef production systems.

#### Action

In autumn of 2007, various legumes species were overseeded into existing bermudagrass pastures at the Batesville Livestock and Forest Research Branch Station. Legumes species included arrowleaf clover, crimson clover, and hairy vetch (annuals) as well as alfalfa, red clover, and white clover (perennials). Pastures are being grazed during the growing season to impose environmental stress to test legume persistence under conditions similar to producer farms. This study will continue during 2010.

#### Impact

Durana White and Cinnamon red clovers appear to persist well in bermudagrass. Hairy vetch shows better reseeding potential than Dixie crimson and Yuchi arrowleaf clovers. With this research, we will be able to provide data on legume persistence and extend knowledge to producers through outreach activities, including on-farm demonstrations, field days, and in-service trainings for county agents. Widespread legume use by producers may substantially lower nitrogen fertilizer costs associated with beef production.

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#### Funding

This study has been funded by grants through NRI/Agricultural Prosperity for Small and Medium Sized Farms; University of Arkansas Division of Agriculture

#### Evaluation of offspring performance due to treatment of replacement beef heifers with ivermectin plus clorsulon or long-acting moxidectin

#### Issue

Intestinal parasitism causes widespread negative effects to cattle production in Arkansas. Parasites lead to decreased feed intake, lowered weight gain, reduced body condition potentially leading to lowered reproductive performance, and decreased milk production causing reduced weaning weights. Anthelmintics continue to be used as the foremost treatment against bovine parasites. Recently, new formulations of longacting anthelmintics have been manufactured for use in beef cattle, but are currently unavailable for commercial use in the U.S. These products have been reported to possess extended effectiveness against internal parasites of cattle. The objective of this study was to evaluate the benefit to offspring performance when ivermectin plus clorsulon or long-acting moxidectin were used to treat replacement beef heifers.

#### Action

A University of Arkansas Division of Agriculture study was conducted on naturally-infected replacement beef heifers (n = 105) for 686 days. The heifers were evenly and randomly allocated to one of three treatments: long-acting moxidectin injectable (MXD), ivermectin plus clorsulon injectable (IVO), and a negative control (CON). Treatments were administered on d 0 and d 149 of the study. On d 175, all heifers were exposed to fertile bulls during an 84 d period. After 63 days of breeding exposure, pregnancy rates of heifers treated with MXD and IVO were higher than CON heifers (82.4, 80, & 69%, respectively), but after an additional 21 days of bull exposure, there were no significant differences in pregnancy rates between treatment groups with an overall pregnancy rate of 93%. Calf birth weights were similar among all treatment groups. Calves born to heifers treated with MXD exhibited heavier average adjusted weaning weights and average daily gain compared to calves from untreated CON heifers (218.6 vs. 199.2 kg & 0.9 vs. 0.82 kg/day, respectively). Average adjusted weaning weights and average daily gain for calves from IVOtreated heifers was not significantly different from calves of untreated CON heifers or from calves of MXD-treated heifers (212.3 kg & 0.87 kg/day).

#### Impact

Replacement heifers treated with long-acting moxidectin and ivermectin had superior average pregnancy rates after 63 days of bull exposure, but no differences were noted after an additional 21 days of exposure. Calf performance (adjusted weaning weight & average daily gain) was greatest for calves born to MXD-treated heifers, intermediate for calves born to IVO-treated heifers, and lowest for calves born to untreated CON heifers. These results indicate more efficient offspring performance can be expected when utilizing anthelmintics during the management of replacement beef heifers. The data from this field study was published in a peer-reviewed journal manuscript. More research should be conducted to continue the investigation of parasite control with the use of long-acting products.

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#### Funding

Fort Dodge Animal Health Overland Park, Kansas University of Arkansas Division of Agriculture

# Identifying genetic markers for resistance to mastitis infection in dairy cattle

#### Issue

Mastitis affects over one-third of all dairy cows, and costs dairy producers an estimated 2 billion dollars annually. Treatment for mastitis may be ineffective, while running the risk of accidental exposure of antibiotics to consumers. Organic dairy producers have no option for antibiotic mastitis treatment, regardless of effectiveness. Research to identify genetic markers or combinations of markers in dairy cattle that are of practical value in identifying cows resistant to mastitis infection, and perhaps, related to overall health status, would benefit all dairy producers.

#### Action

A low-sodium medium was found to be a viable alternative to synthetic caudal epididymal fluid medium for maintaining sperm viability during storage. Improvement in semen storage procedures could enhance the efficiency and use of artificial insemination, especially in species where the semen can not successfully cryopreserved.

#### Impact

The ability to alter the gender ratio of offspring in livestock would be of great economic benefit to producers. Results

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confirm that the sex ratio of semen may be skewed in individual ejaculates of semen but suggests additional studies are needed to determine any predictive value of sperm motility parameters or morphology in identifying ejaculates of semen with skewed sex ratio. Being able to identify and/or predict a skewed sex ratio in individual ejaculates of semen may lead to a practical, cost effective method to control the sex of offspring in livestock species.

Although a single bull can greatly influence the productivity and profitability of cow-calf operations, most previous research has focused on the effects of endophyte-infected fescue on cows. Our results show that grazing bulls on endophyte infected fescue reduces sperm motility and morphology, especially during elevated ambient temperatures. Awareness of this effect should lead to better management practices to avoid fertility problems and improve cow herd productivity and profitability.

Many cattle producers do not have the equipment or expertise to utilize artificial insemination. In such cases, technicians can be contracted to synchronize herds and use timed insemination to breed all cows at a single time to reduce costs. Identifying bull semen best suited for timed insemination would be of great benefit. Reducing the length of synchronization protocols would make the procedures more acceptable to producers and possibly increase utilization.

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#### Funding

University of Arkansas Division of Agriculture

# Genetic markers can help evaluate reproductive efficiency

#### Issue

Reproductive rates have a major impact on the sustainability and profitability of beef cow-calf operations. During the last 50 years animal breeding methods have increased cattle growth rates; however, due to the low heritability coefficients for reproduction their methods have not been effective at improving reproduction. The national average for the percentage of cows that wean calves is approximately 70 percent. Obviously, reproductive success in a cow herd is dependent on both fertile cows and fertile bulls. Weaning weights and scrotal circumference are typical selection criteria for bulls, and have been associated with their daughter's fertility. However, in some cases the predicted daughter success is not realized.

#### Action

Using candidate genes we have identified single nucleotide polymorphisms (SNPs) that are related to fertility and calving rates of beef cows. In one case, we have identified an allele in the upstream elements of the heat shock protein 70 (HSP70) gene that is associated with heavier weaning weights and larger scrotal circumference of bulls, however, that same allele is associated with decreased calving rates of cows. That SNP could be very useful in selecting bulls that will sire heifers that will mature into cows with high fertility. In addition, we have identified a SNP in the coding sequence of HSP70 that has an allele that is associated with decreased calving rates for cows that are grazing toxic tall fescue. These projects were the result of a team consisting of graduate students, undergraduate researchers, laboratory personnel, and scientists in the animal science department and USDA/ARS.

#### Impact

Using our DNA technology to evaluate cattle could result in cow herds that have greater calving rates. Arkansas cattle industry consists of nearly one million cows; therefore, the potential benefits for our industry are large.

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#### Funding

USDA/ARS Cooperative Agreement with Dale Bumpers Small and Family Farms Center, University of Arkansas Division of Agriculture, Arkansas Agricultural Experiment Station, Animal Health Formula Funds

National Research Support Project, NRSP-008 Multistate project, W-1171 SERA-IEG 8

# Economics of stocker grazing on conservation tillage winter wheat in Arkansas

#### Issue

Many areas of Arkansas are well suited for grazing stocker calves on winter wheat forage, but few cattle operations have taken advantage of this potential value-adding opportunity. In addition, many areas that could potentially benefit from this practice are highly erodible, and conservation tillage winter wheat forage management may be needed to best ensure the existing natural resource base is not degraded over time. Profit generation is also a major consideration when evaluating alternative winter wheat forage production methods. Conventional tillage requires the use of large and expensive pieces of equipment and is very fuel and labor intensive. In contrast, conservation tillage systems require less machinery and equipment and are less fuel and labor intensive. However, conservation tillage systems control weeds by substituting herbicides for tillage either partially or exclusively, and the additional cost of herbicide applications can be substantial. This study evaluates both profitability and return variability of grazing stocker steers on conservation tillage winter wheat pasture using simulation analysis.

#### Action

The simulation model SIMETAR (Simulation and Econometrics To Analyze Risk) is used to simulate 500 iterations of average daily gains (ADGs), steer purchase and sell prices,

death loss percents, and prices for key winter wheat forage production inputs (diesel, fertilizer, and glyphosate). These data are then used along with input and field operation data from experimental winter small grains pastures at the Livestock and Forestry Branch Station (LFBS) near Batesville, Arkansas to calculate net return distributions for stocker steers grazed on winter wheat forage produced under conventional tillage (CT), reduced tillage (RT) and no-till (NT) management. Average daily gains are simulated based on seven years of stocker weight gain data varying by tillage treatment from the LFBS. Steer prices are simulated based on historical steer price data from the Arkansas Weekly Livestock Summary (USDA, Agricultural Marketing Service). Prices for key production inputs such as diesel, fertilizer, and glyphosate are simulated based on historical April US prices for urea, diammonium phosphate (DAP), potash, diesel, and glyphosate obtained from the USDA, National Agricultural Statistics Service. All weight gain and historical price data used in the simulations are collected for the period 2002-2003 to 2008-2009.

#### Impact

The results indicate stocker steer returns are greater on average and are least variable under the NT wheat forage system, while stocker steer returns are smallest on average and most variable under the CT wheat forage system. Average stocker steer net returns to the three systems were \$56, \$37, and \$12 per acre for NT, RT, and CT, respectively. The results also indicate that all three forage systems have potential to be both highly lucrative and highly unprofitable. Maximum returns ranged from \$390 per acre for NT to \$355 per acre for CT, while minimum returns ranged from -\$313 per acre for RT to -\$341 per acre for CT. Of the three forage systems, the NT system had the smallest probability of receiving a negative return (32 percent) followed by the RT system (37 percent) and the CT system (45 percent). These results imply that winter wheat forage systems that keep tillage to a minimum and that maintain the natural resource base have the greatest probability of generating positive returns to stocker grazing.

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#### Funding

NRI Competitive Grant; University of Arkansas Division of Agriculture

#### Water quality in poultry production

#### Issue

Water is the single greatest input in the production of poultry (birds consume approximately 2 pounds of water for every pound of feed). Even with the use of enclosed drinker systems, drinking water may contain pathogenic bacteria. In addition, consumer demand to reduce antibiotic use in poultry production has left the poultry industry with fewer tools to solve health problems in poultry flocks.

#### Action

Finding solutions to control pathogens at the farm level is a top priority for the poultry industry as USDA-FSIS pushes for on-farm control of pathogens such as Salmonella. Solutions that not only reduce the incidence of Salmonella positive flocks but also improve the health, productivity, and profitability of flocks would be a win-win for the industry. Gas chlorination and acidification of the drinking water for broilers was evaluated as a potential method for preventing Salmonella contamination. A system was installed in a barn at the University of Arkansas Division of Agriculture poultry research farm that injected gas chlorine into the water supply followed by an acid injector, which lowered the pH of the water so that chlorine existed primarily in the hypochlorus acid state. This resulted in a free chlorine residual of  $\geq$ 1ppm and an Oxidation-Reduction Potential of 750 mV. Birds were exposed to nalidixic acid resistant Salmonella at either 7 or 35 days of age and given either the treated water or non-chlorinated control water. Results indicated that the treatment significantly reduced the incidence of Salmonella in the ceca of 42 day old broilers exposed to Salmonella at 35 days of age but not effective for birds exposed to Salmonella at 7 days of age.

#### Impact

This information could have a significant impact on the poultry industry as it looks for economical and effective methods for on-farm control of pathogens in broilers that are exposed near market age to the food borne pathogen *Salmonella*.

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#### Funding

University of Arkansas Division of Agriculture

# Epidemiology and control of helminth parasites in Arkansas farm animals

#### Issue

Helminth (worm) parasites are common pathogens in all farm and companion animals. Parasite life cycles and schemes of animal maintenance (husbandry) ensure that 100% of our animals harbor helminth parasites. Ill conditions suffered by host animals range from clinical (including death) to miniscule (no measureable significance). For our production animals, parasitisms are usually subclinical (no visible signs) but economically important, with most losses due to lowered feed efficiency and reduced animal productivity. It is estimated that animal productivity in the U.S. is reduced by 10% as a result of "normal" worm infections. Regrettably, no control measures are absolute in efficacy, with management and chemical means of intervention providing only partial and short-lived reductions of parasite populations. Additionally, with an increase in the numbers of organic and natural production systems, less parasite control is available for more and more animals.

#### Action

Studies were conducted in 2009 to obtain data relative to helminth control in cattle and poultry. Our poultry work is ongoing, with conclusions to be drawn from the data next year. In cattle, we conducted a large control study to document the efficacies of moxidectin, ivermectin, fenbendazole and oxfendazole; four chemicals which account for the vast majority of anthelmintic usage in the U.S. Fenbendazole and oxfendazole were highly efficacious except for their limited capacities to remove arrested nematodes. Ivermectin was shown to be less than effective for *Cooperia* burdens (common parasites in animals <2 years of age) with an efficacy of 77-84% (90% is required in order to be considered effective). In addition, ivermectin showed signs of loosing efficacy against arrested brown stomach worms (*Ostertagia*), with efficacies of 82-92%. Moxidectin was demonstrated to be >97% effective against all worm burdens evaluated, and is therefore considered to be the drug of choice for utmost worm protection in all cattle, regardless of season.

#### Impact

From the above results, a clear comparison of the most popular parasiticides has now been made available for cattle producers. Producers can now consider effectiveness along with cost when it comes to selection of worm control products. The better the product, the more worms that are removed, and the more productive (and healthy) the animals; all pointing to greater profit for the producer.

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University of Arkansas Division of Agriculture; Intervet/ Schering; Fort Dodge Animal Health/Pfizer; Alpharma/King Pharmaceuticals; Merial

#### Competitive Agricultural Systems in a Global Economy

### **Plant Systems**

### Seed treatments to protect rice against two insect pests

#### Issue

Rice growers know that large numbers of insects can influence plant stands and plant growth. Two such pests are the grape colaspis (lespedeza worm) and the rice water weevil, both of which are common to silt loam soils in Arkansas. Several years ago, growers used an insecticide applied to seed before planting to control both pests. Removal of that seed treatment from use resulted in less convenience for growers, less uniform stands of rice, increased damage by pests, and increased amounts of insecticide in the environment.

#### Action

University of Arkansas Division of Agriculture rice entomologists partnered with the agricultural industry to assess several new candidate seed treatments. Field studies were conducted with two active ingredients-rynaxypyr and thiamethoxam. Small plots with natural infestations of pests were used to test ranges of rates of the seed-treated insecticides for efficacy against rice water weevil and grape colaspis. Rice water weevil larvae were controlled by both rynaxypyr and thiamethoxam up to five weeks after permanent flood or about eight to nine weeks after planting. Rynaxypyr gave good control of rice water weevils, but less control of grape colaspis larvae. In contrast, thiamethoxam controlled grape colaspis larvae and was effective against rice water weevils. In addition, thiamethoxam helped reduce numbers of early-season, piercing-sucking insects, such as aphids and chinch bugs; and rynaxypyr helped reduce numbers of armyworms and stalk borers.

#### Impact

Our research results give rice growers information to make informed decisions about the option to use seed treatments against these two important rice pests. Growers with a history of severe stand losses can use the seed treatment that controls grape colaspis and rice water weevils. Growers with a history of severe damage to roots and yield losses from rice water weevil can use the treatment that best controls weevils and reduces damage from grape colaspis. Seed treatments should also result in less environmental impact from insecticides.

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#### Funding

Arkansas Rice Research and Promotion Board, University of Arkansas Division of Agriculture, Syngenta Crop Protection, and Dupont Crop Protection

### New approaches in the fight against fungal diseases of Arkansas crops

#### Issue

Fungal diseases affect virtually every crop grown in Arkansas, often substantially reducing growers' profits. One of the most sustainable and cost-effective ways to counteract fungal diseases is to improve crops' resistance to disease. A thorough understanding of how plants and pathogens interact during disease development can help identify new resistance genes, improve genetic screens used by plant breeders, accelerate the development of new fungicides, and support the development of genetic modifications such as Round-up Ready<sup>®</sup> technologies.

#### Action

This project focuses primarily on diseases caused by Cercospora spp. (including frogeye leaf spot and purple seed stain of soybean, as well as gray leaf spot of corn), Fusarium spp. (including stalk and ear rot of corn, stalk rot and head mold of sorghum, head blight of wheat, and sudden death syndrome of soybean), and Aspergillus spp. (including ear rot of corn and head mold of sorghum). Identification of pathogens that could constrain the production of biomass crops used in the Arkansas biofuel industry is also of interest. A wide range of sophisticated biochemical and genetic tools to identify genes in the pathogen required for disease, as well as genes in the plant that activate resistance were used. Attention was focused specifically on preventing the accumulation of mycotoxins in Arkansas crops, including aflatoxins and fumonisins in corn and sorghum, as well as vomitoxin in wheat. Numerous plant and fungal genes involved in disease development were identified, and efforts are ongoing to describe their exact function.

#### Impact

Although this is a relatively new project, substantial progress has been made towards our goals. Populations of the pathogen causing frogeye leaf spot in soybean are much more genetically diverse than previously thought, and it is recommended that soybean breeding programs consider this diversity when assaying for resistance. A novel technique to identify fungal genes responsible for ear rot diseases of corn has been created and a much more detailed understanding of what triggers some fungi to produce mycotoxins is under development. Other AES personnel are engaged to develop mycotoxin-resistant corn varieties through transgenic approaches. A disease of switchgrass, a promising biofuel crop has been identified, that was previously undetected in Arkansas. All of these activities provided training and education opportunities for undergraduates and graduate students, many of whom are native Arkansans.

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#### Funding

University of Arkansas Division of Agriculture

#### COTVAR, a computer program for comparing performance of cotton varieties, expanded to include all state variety tests

#### Issue

State Cotton Variety Trials have been conducted over several decades in approximately 15 states. Results are published and routinely made available in hard copy. On-line delivery of data is a more recently developed tool made available to growers. However, comparison of data from different states is still very difficult because varieties vary among test sites and are usually sorted by relative yield at a location. In addition, variety names often cause much confusion because they may be tested as an experimental number then later changed to a commercial name. Growers need a more user friendly and customized delivery approach to allow comparisons to be made.

#### Action

A computer program, named COTVAR, was developed and subsequently released in 2007. With COTVAR, users can easily compare performance of cotton varieties in state variety tests. At present, the program utilizes data from state variety tests in Arkansas, Louisiana, Mississippi, Missouri, and Tennessee. Each year, cotton varieties are evaluated at approximately 30 sites over these five states. Data and programming is now underway to expand COTVAR to include all states that conduct cotton variety tests. The revised program is expected to be available on-line early in 2010. With the revised program, the user will initially choose one of three testing zones (east, central or west). Each zone will then run as the current COTVAR program now runs. Users can select specific test sites within a zone (based on GPS coordinates, irrigation, and/or soil type) or regions, then compare varieties, which are characterized by type (convention, single or stacked transgenes) and by status (commercially available, experimental, or obsolete). Data generated include yield, lint fraction, and fiber properties. The COTVAR program was written by Chalmers Davis and Becky Bridges, University of Arkansas Cooperative Extension Service, and is available on line at http://cotvar.uaex.edu/intro.asp. The revised program with zones will be available at the same site.

#### Impact

Other than technology fees, planting seed costs of different cotton variety does not vary greatly. However, yields of varieties may different greatly in specific environments. Therefore, selecting the variety that will most likely perform best is essentially a no cost decision that can provide great returns for the cotton grower. The COTVAR program will assist producers to make informed choices with regard to variety selection.

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#### Funding

Cotton Incorporated; University of Arkansas Division of Agriculture

# Q-Score, a numerical index for identifying cotton fiber quality

#### Issue

Improved fiber quality is needed for the continued competitiveness of U.S. upland cotton. Unfortunately, cotton genotypes, which display superior fiber quality, are often latematuring and do not yield well over different environments. Since fiber quality may be characterized by different methods and measurements, superior fiber quality is sometimes difficult to define and identify. Most cotton breeding and cultivar testing programs utilize High Volume Instrument (HVI) determination of fiber parameters, and most frequently report fiber length, length uniformity index, strength and micronaire. Users of these data are challenged to determine which parameter or group of parameters should be given priority. A numerical index, which characterizes variation in cotton quality, would be a great asset to cotton breeding and cultivar testing programs.

#### Action

We have developed a numerical index, "Q-score", based on four frequently reported fiber parameters. Fiber properties (weights) for Q-score calculations that we currently use (fiber length, 50%; micronaire, 25%; length uniformity index, 15%; and strength, 10%) were suggested by fiber experts at Cotton Incorporated. Data from the 2001-2007 Arkansas Cotton Variety Tests indicated that Q-score values were normally (or near normally) distributed, while loan values followed a Poisson or chi-square distribution. Q-score and loan value were positively correlated, and similarly correlated to the fiber parameters. Q-score was more conservative and discriminating than loan values. Data for 16 cultivars at four sites over three years indicated that Q-score values were relatively consistent over years and sites. Q-score was also normally distributed in data extracted from the 2005-2008 Arkansas cotton breeding trials. This distribution facilitates subsequent development of superior cotton lines. These results indicate that Q-score may assist with characterizing fiber quality. However, application of Q-score is limited because relative weights of four fiber traits are subjectively assigned, and measurement of trash and color are not included. Q-score may be calculated using an Excel Macro spreadsheet, which is available from Cotton Incorporated (djones@cottoninc.com). Users of Q-score may vary weights of fiber properties to meet their specific needs.

#### Impact

By quantifying fiber quality into a single index, Q-score facilitates the selection of cotton lines that combine both high yield and high fiber quality. Recently developed lines in the University of Arkansas Cotton Breeding Program illustrate the positive value of using Q-score. Lines having both improved yield and fiber quality will enhance the competitiveness of Arkansas and U.S. cotton production.

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#### Funding

Cotton Incorporated; Division of Agriculture, University of Arkansas

#### Arkansas cotton germplasm lines provide high yield and host-plant resistance in broadened germplasm base

Issue

Over the past five years, 33 germplasm lines have been released by the University of Arkansas cotton breeding program. These lines have generally displayed enhanced host-plant resistance, improved yield, earliness, varied morphological traits, and/or enhanced fiber properties. Several of the releases have led to the development of privately owned varieties that are highly adapted to Arkansas conditions. Continued development and release of cotton lines will help Arkansas cotton producers to have adapted, competitive varieties.

#### Action

The Arkansas Agricultural Experiment Station released two cotton germplasm lines in 2009. The two lines were derived from crosses made in 1998 followed by development and testing. The lines broaden germplasm base by integrating 'FM 989' (a parent of Arkot 9811) and 'GC 251' (a parent of Arkot 9815) with germplasm previously developed in this breeding program. Each line was selected for high yielding capability (multiple in-state and regional tests), yield stability (via yield components), resistance to specific pests, and fiber quality.

Lint yields of Arkot 9811 and Arkot 9815, which were equal to two check cultivars 'DP 393' and 'SG 105', could be attributed to similar lint per seed and fewer seed per area than either check cultivar. Both lines appeared to be best adapted to north Delta test sites. Fiber properties of both lines tended to be slightly inferior, similar to the check cultivars.

For both lines, leaf pubescence was slightly higher, but marginal bract trichome density was lower than either check cultivar. Both lines expressed resistance to bacterial blight. Arkot 9815 expressed higher resistance to tarnished plant bug than either check cultivar, while Arkot 9811 expressed lower resistance than DP 393. The relative yield and line-specific host-plant resistance traits make these lines valuable to cotton breeding programs.

#### Impact

Public and private cotton breeders are using these lines as parents in their breeding programs. Varieties that are developed using these lines should be better adapted to Arkansas and should provide improved host-plant resistance and fiber quality.

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#### Funding

Cotton Incorporated; University of Arkansas Division of Agriculture

#### **Ryegrass in wheat**

#### Issue

Ryegrass is a major weed problem in wheat production. It has developed resistance to diclofop, the main herbicide used for ryegrass control, which results in serious yield losses. Repeated use of the same herbicides have selected for resistant individuals.

#### Action

Our research methods include: annual testing of suspect populations using all potential ryegrass herbicides in wheat; determination of resistance profiles based on efficacy tests and gene sequencing experiments; development of in-season detection technique of resistant ryegrass using an agar-based bioassay method. Results of these tests are relayed back to growers, via the extension agents who submitted the samples. A comprehensive survey of herbicide resistance patterns among ryegrass populations in Arkansas (from wheat fields and non-crop areas) was also initiated.

#### Impacts

Extension personnel and company representatives are able to advise their growers prior to the herbicide application time on what herbicide can be used on their field to control ryegrass in wheat. Follow-up research on alternative management options for ryegrass, including integration of newly labeled herbicides, with and without residual soil activity, as well as emergence patterns and physiological basis for resistance are now included in the agenda of ryegrass management.

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#### Funding

Bioassays conducted in 2009 were partially funded by Dow AgroScience and Syngenta Crop Protection. Partial funding was also obtained from the Arkansas Wheat and Promotion Board. University of Arkansas Division of Agriculture

# The physiology, biology, and ecology of weedy (red) rice

#### Issue

Red rice is a weedy relative of rice. It is the second most problematic weed in U.S. rice production and a major problem worldwide wherever rice is produced. This cannot be controlled by traditional rice herbicides, which prompted the development of herbicide-resistant Clearfield<sup>TM</sup> rice. This technology underscores the gene flow issue between rice and weedy rice; thus, comprehensive research on weedy rice is being pursued.

#### Action

To follow up on previous research, a project on the evolutionary dynamics of weedy rice was initiated. Seeds of up to 15 plants were collected from rice fields representing the three ecozones of rice production in Arkansas. Sampled plants are being characterized with respect to morphology, phenology, and seed dormancy. The sequences of STS loci of selected plants from the new and old collection will be analyzed.

#### Impact

The generation of comprehensive knowledge about the phenotypic, phenological, seed dormancy, and genetic diversity of red rice in Arkansas will impact management recommendations. The stewardship recommendations for herbicideresistant Clearfield rice used information from this research.

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#### Funding

USDA CSREES-NRICGP; University of Arkansas Division of Agriculture

#### Weed control options for cowpea

#### Issue

Cowpea is a significant vegetable crop in the southern U.S., although it is a minor use crop in the bigger scheme of U.S. agriculture. There are few herbicide options for cowpea and resistance to some of these herbicides is now a problem in cowpea production.

#### Action

Experiments on tolerance of cowpea to various herbicides were conducted.

#### Impact

Expansion of the label of sulfrentrazone + carfentrazone (Spartan® Charge) is being pursued under section 24c for cowpea in Arkansas. This provides growers with a better option for preplant herbicide application in cowpea involving sulfentrazone. Sulfentrazone is safer on cowpea when applied one week prior to planting and the addition of carfentrazone broadens its spectrum of activity. This is a tool that growers can use to manage ALS-resistant and glyphosate-resistant Palmer amaranth. This also makes stale seedbed or no-till cowpea production more feasible.

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#### Funding

Allen Canning Co., IR-4, FMC Corp, University of Arkansas Division of Agriculture

# The potential of sweet sorghum and canola as alternative biofuel crops

#### Issue

This research contributes to the statewide pursuit of building up infrastructure and resources for biofuel production. Sweet sorghum has many advantages over corn or soybean as a biofuel crop, mainly the ability to produce a large amount of biomass in marginal growing conditions. Canola is an alternative oil seed crop that has great potential for production in Arkansas.

#### Action

Experiments are under way to evaluate the performance of sweet sorghum under irrigated and non-irrigated conditions and evaluate herbicide options for early season weed management. Crop tolerance to herbicides and herbicide carryover experiments were conducted to support the overall crop production program for canola.

#### Impact

It is premature to determine the impact of the project on growers. However, the sweet sorghum project has already proven useful to several researchers and even some processors. Researchers on sweet sorghum processing, commercial ethanol plant, and agricultural economics have utilized sweet sorghum biomass generated by this project to conduct downstream investigations pertaining to processing and market efficiency. On the other hand, canola shows high tolerance to residual herbicides applied to summer crops. Among the expected impacts would be the diversification of cropping systems and improvement of agricultural profitability in Arkansas.

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#### Funding

Arkansas Agricultural Experiment Station, DOE Mid-South Consortium on Biofuel Feedstock, Syngenta, FMC, BASF, University of Arkansas Division of Agriculture

# 'Lower risk' grain sorghum hybrids can increase yields

#### Issue

Grain sorghum has historically been a lower input and lower yielding crop in Arkansas. While affected by various soilborne diseases consistently, foliar disease impact in typical

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production has been ignored. Certain growers have attempted to more intensively manage grain sorghum and improve productivity. In addition, foliar fungicides were recently registered for use. Information on impact of foliar diseases on different hybrids, grain sorghum yield, and efficacy of new fungicide products have been lacking for Arkansas, especially in higher input management systems.

#### Action

Starting in 2008, we began to address the issue by establishing cooperative field trials on different cooperator farms and experiment stations. In 2008, 6 studies were completed and harvested, while 5 were completed in 2009.

#### Impact

Results showed that cultivars differed in resistance to various foliar diseases in both years, indicating a range of disease resistance available among the many grain sorghum hybrids sold. In 2009, a severe outbreak of anthracnose disease occurred in sorghum trials at the Lon Mann Cotton Branch Experiment Station near Marianna, Ark. Trials at this site were planted to sorghum for the second year in a row, resulting in considerable residue and pathogen inoculum from the previous year. At the Marianna location, cultivars with greater disease resistance usually had the highest yield. Compared to statewide yield results, at least three of the disease resistant hybrids at Marianna also had some of the highest statewide yield averages. This information has been used in grower meetings and handouts to illustrate the importance of selecting cultivars based on yield potential and risk potential. A hybrid with high yield potential and lower disease risk is more likely to be profitable, year in and year out.

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#### Funding

Arkansas Corn/Sorghum Promotion Board; University of Arkansas Division of Agriculture

# Soybean seed quality a continuing concern in Arkansas

#### Issue

For the second year under study, problems associated with seed quality in the state occurred during June and July. The 2009 crop was planted late, due to excessive and untimely spring rains. In some cases in late June and during July, planted seed failed to emerge or had poor vigor upon emergence. Stand failure is expensive, and the source of failure is difficult to determine, given the limited quality information available for seed sold in the state, and the diversity of climate and seedbed factors faced during summer planting.

#### Action

A team of scientists in the University of Arkansas Division of Agriculture's department of plant pathology and crop, soil and environmental sciences established a comprehensive research and extension project in April 2008 on soybean seed quality. For the second year, a statewide planting seed survey assessed 442 samples from 30 counties from April thru July. These samples were tested by three labs for standard germ, and seed vigor, using the accelerated aging test; and stand establishment in sampled fields was recorded. The group also conducted various field trials to assess genetic factors involved in seed quality and a seed storage experiment in cooperator warehouses at three sites.

#### Impact

For the second year, standard germ of collected samples did not decline much over time; however vigor results (accelerated aging) did, and were more variable in general. In addition, field emergence observations indicated better correlation with accelerated aging values than with standard germ, similar to results noted in 2008. Field trials using different genotypes indicated genetic control of weathering, susceptibility to certain seed pathogens, and possibly other seed quality factors.

Advice to growers as a result of this project continues to be: Ask for all available information about seed lots being purchased, especially seed vigor; Try to determine the vigor of purchased seed lots as close to planting as possible, even if it means having seed tested again; For seed not possible to test in time because of late delivery, a small sample should be kept in a seed sample bag in an air-conditioned room until stand establishment can be determined. As seed prices continue to escalate, this project remains of high interest to Arkansas soybean growers.

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#### Cooperators

Ohio State University, Kentucky Department of Agriculture; Arkansas State Plant Board; University of Kentucky; selected regional seed companies.

#### Funding

Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture

# New soybean cultivars offer growers high productivity and profitability

#### Issue

Soybean is an important commodity in Arkansas and ranks on the top in acreage among all agricultural crops. Over three million acres of soybean are grown each year, generating approximately 115 million bushels in total production and about \$950 million in gross income. Choosing a proper variety is one of the most important decisions a grower has to make each growing season. There are many varietal characteristics,
such as yield potential, maturity, adaptation, disease resistance, herbicide resistance, and seed quality, which need to be considered in matching the best variety for a particular cropping system or production environment. The numerous varieties available to Arkansas growers come from publicly funded breeding programs in the southern states and from private companies.

#### Action

The long-term goal of our soybean breeding program is to develop varieties with high productivity and profitability. Our specific objectives for variety development include high yield potential, good local adaptation, various maturities, multiple and durable disease resistance, stress tolerance, conventional and herbicide resistance, lodging and shattering resistance, and improved seed quality. We have established a strong breeding program and an extensive variety-testing program to assist our soybean producers in selecting the best varieties to grow. Arkansas soybean producers provide check-off funds administered by the Arkansas Soybean Promotion Board to support the soybean breeding program.

#### Impact

More than 20 varieties have been released from the University of Arkansas' soybean breeding program and had significant impact on Arkansas soybean production. Growing a high-yielding variety does not cost more than growing an average variety. Every bushel of extra soybean yield produced by growing the high-yielding variety is a net income to the growers. Higher yields from new and improved varieties should translate into higher profits to Arkansas soybean producers, particularly when productions costs are high. Varieties with disease resistance and stress tolerance will also prevent yield loss under unfavorable production conditions. In addition, public programs supply thoroughly-tested varieties with low cost seeds that can be saved for planting, which provides additional savings for the growers. Three new conventional varieties (Osage, UA4805, and Ozark) have been recently released to the public. They all have high yield potential, good disease resistance, and excellent local adaptation. Foundation seeds are available for commercial production. Growers can also get certified seeds from local seed dealers.

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#### Funding

Arkansas Soybean Promotion Board, University of Arkansas Division of Agriculture

#### Specialty soybeans add value to the farm

#### Issue

Growing an adapted variety with high yield potential is the cornerstone for achieving profitable soybean production. Public breeding programs have played an important role in the yield increase by both releasing varieties and providing parental materials to private seed companies. Private companies often neglect specialty soybean traits that may have a relatively small market and require long term investment. With the increasing global market competition in recent years, soybean farmers need to find ways of cutting down the production cost and increasing the crop value. If soybean production is to remain profitable, we need to investigate the potential of the specialty soybean market and the value-added soybean production.

#### Action

The expanding soybean-based food market in Japan and the U.S. has generated considerable interest among soybean producers. The demand for food-grade soybeans has been increasing due to the proved and publicized health benefits and nutritional value from soyfood products such as tofu, natto, soymilk, soysauce, miso, soynuts, edamame, and bean sprouts. A new breeding program has been initiated at the University of Arkansas in an attempt to develop high-yielding specialty varieties with improved seed-quality traits. We focus on breeding and selections for proper seed size, high protein, low trans-fat oil (low linolenic acid and mid-oleic acid), proper sugar and calcium content, soft texture, high isoflavone, and lipoxygenase-free. Varieties released from this program will be commercialized in Arkansas for production and seeds will be provided to domestic manufacturers or exported to other countries. In addition, we are developing high protein and low phytate soybeans for specialty feed that would increase feeding efficiency and improve environmental pollution. Recently, research has been initiated to develop high oil soybeans for bio-diesel production.

#### Impact

Growing a specialty variety does not require extra production input, but may result in slight yield reduction. However, growers are offered premiums ranging from \$1.5 to \$3.0 per bushel as incentives to produce the specialty seeds. The high quality food-grade soybeans, produced conventionally or organically, are often sold at a much higher price than regular commodity soybeans. Therefore, every bushel of extra yield would not only generate extra net income from soybean sales, but also gain additional production premiums. In addition, farmers can save seeds from their own crop harvest for planting next season, thereby ensuring identity preservation and reducing/eliminating seed costs. The specialty soybeans will play an important role in expanding the niche markets for soyfood, feed, and nutriceuticals, and therefore enhance the overall soybean production.

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#### Funding

Blue Horizon Inc. and Toyota Tsusho Corporation, University of Arkansas Division of Agriculture

## Arkansas blackberries broaden options for U.S. markets

#### Issue

Improved blackberry varieties along with improved postharvest handling have led to a substantial increase in blackberry marketing in the U.S. and worldwide. Once a fruit picked only in the wild, U.S. retail grocery stores maintain blackberries on shelves year around with a mix of domestic and imported production. Additionally, enhanced quality and flavor along with an interest in healthy foods have helped expand this market. New breeding and genetic improvements have helped feed this demand and are benefitting both growers and consumers of this high-value, high-health berry.

#### Action

The University of Arkansas fruit breeding program has been working with blackberries since 1964 with major goals such as enhanced quality, large fruit size, thornless plants, and more recently the unique primocane-fruiting trait. A series of thornless, floricane-fruiting blackberry varieties has been released including Navaho, Apache, Arapaho, Ouachita, and most recently Natchez. These varieties have been grown in Arkansas, across the south, and from east to west coasts of the nation. The first primocane-fruiting varieties were released in 2004, Prime-Jan® and Prime-Jim®, both intended for the home-garden market. A breakthrough occurred in 2009 with the release of the first shipping-quality primocane-fruting blackberry Prime-Ark® 45. This new variety provides the basis for further expansion of the fresh-market blackberry industry particularly in the valuable late summer to fall fruiting season where few blackberry varieties exist that ripen late in the year.

#### Impact

Since the winter of 2006-2007, approximately 2.5 million of the University of Arkansas-developed blackberry varieties have been sold in the nursery market, providing for an expansion of potentially 2000 acres of new production. The largest seller, Ouachita, has proven to be a reliable producer of excellent quality in numerous states. Likewise, Navaho, Apache, and Natchez have made substantial headway in new plantings. The release of Prime-Ark® 45 will further expand production to bridge the gap between later-season U.S. production and the beginning of substantial importation of blackberries from Mexico in November. Specialty crop grower profits, consumer needs, and overall enhanced nutrition are all being served by these genetic advances.

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#### Funding

University of Arkansas Division of Agriculture Fruit variety royalties

### White peach variety options continue to expand grower and consumer opportunities

#### Issue

The American consumer has a much-expanded range of choices of fruits and other items of produce in retail markets. Gone are the days when peaches were simply yellow freestone, very similar in color, quality, and overall eating experience. In retail markets, options in peaches include white and yellow flesh, melting and non-melting texture, low and standard acid flavors, and round and flat shapes. However, many of the varieties of these varied peach types are limited in where they can be grown successfully. Breeding for broader adaptation to varied climates has provided the basis expanded variety options for growers for both retail and local market options.

#### Action

The University of Arkansas fruit breeding program has been working to expand and improve peach variety options for eastern and mid-south U.S. producers. A major focus has been on white peaches, since these are considered a specialty item by consumers, and can lead to high profitability. Additionally, varied flavors and textures, as often found in retail markets from sources from the western U.S., have broadened consumer profiles and breadth. The release of White River in 2000 provided an improved white peach for the mid-South and eastern U.S., with good bacterial spot resistance. This disease is not found in dry regions, but can be devastating in the eastern U.S. and varieties developed out of this region can be impossible to successfully grow. In 2004, White Rock and White County were released, providing two low-acid-flavored white peaches with good adaptation. In 2009, two additional white peaches were introduced, White Cloud and White Diamond. These new varieties expand options for extended season white peach production in areas with substantial bacterial spot disease pressure.

#### Impact

Arkansas-developed white peaches are now being planted by eastern U.S. growers and production of this specialty item is increasing in small and large plantings. With the range of varieties released, the fruiting season extends for nearly two months from mid June to mid August. Further industry expansion is anticipated as more growers consider moving to these new innovations in new planting establishment. Expanded grower profits and enhanced eating experiences by consumers will be realized.

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#### Funding

University of Arkansas Division of Agriculture, Fruit variety royalties

# High flavor table grapes offer unique options for specialty table grape producers

#### Issue

The American consumer has a very limited choice in table grapes. Almost all retail markets are limited to *Vitis vinifera* options produced largely in the Central Valley of California or from imports from South America. The varieties grown there are not adapted to the majority of the U.S. due to limitations in plant hardiness, fruit cracking tendency, and disease susceptibility. Local producers of specialty crops have very diverse markets to utilize, such as on-farm markets, farmers markets, and other high-profit options. The addition of table grapes to these markets can help diversify grower and consumer choices. Grapes with expanded flavors offer such an option. Breeding for diverse flavors, colors, and broader adaptation to varied climates has provided new opportunities.

#### Action

The University of Arkansas fruit breeding program undertook table grape improvement beginning in 1964. Varieties that have been produced include Venus, Reliance, Mars, and Saturn. The newer introductions Jupiter and Neptune offer advances in texture along with unique flavors. These two varieties are considered "non-slip" skinned grapes, more similar to the texture of grapes that consumers are accustomed to. However the unique fruity flavors of Jupiter and Neptune provide a powerful eating experience. Further, the program continues to develop and evaluate a greater range of genotypes for potential introduction for commercial use to expand grower choices in the future.

#### Impact

Expanded plantings, particularly of Jupiter, in a range of states in the east and Pacific Northwest are increasing the supply of fruit for consumers. Consumers are finding these unique grapes to be an exciting purchase at local markets along with limited shipping of fruit to more standard retail outlets. High value and diversity of specialty crops are keys to grower profitability, and the new table grape variety options are fulfilling a niche market that can potentially expand in a range of environments in the U.S.

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#### Funding

University of Arkansas Division of Agriculture Fruit variety royalties

# Improving foliar disease management for soybean production in Arkansas

#### Issue

Environmental conditions favoring profitable soybean production; unfortunately, also favor the development of numerous foliar diseases which occur each year in the state. Indiscriminate use of fungicides is not conducive to management for profitable soybean production.

#### Action

We have developed a foliar fungicide screening program to evaluate application thresholds, timings, and rates of soybean fungicides to an array of our most common endemic foliar diseases. This program utilizes artificially inoculated plots and naturally infested plots as appropriate to evaluate and refine foliar disease management recommendations to our soybean producers as "new fungicides" come on the market in the southern U.S. These replicated trials represent a comprehensive effort to improve our economically sustainable soybean production systems by fine-tuning foliar disease management recommendations which contribute to profitable soybean production. All information is made available to growers, consultants, crop advisors, extension personnel, and the soybean industry through websites for immediate access.

#### Impact

Yield losses in Arkansas each year due to foliar diseases have been estimated by the Southern Soybean Disease Workers group at around 10% or about 12 million bushels. Proper fungicide selection, rate, and timing could conservatively reduce these losses by at least half, with a resulting annual increase of over 6 million bushels of soybeans harvested by Arkansas producers.

#### Contacts

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#### Funding

Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture

### Identification of new races of the spinach downy mildew pathogen and molecular markers linked to disease resistance

#### Issue

Downy mildew of spinach is the most economically important disease of spinach worldwide. We have identified a new race in 2008 (race 11) and a new race in 2009 (race 12) and this rapid race development has caused considerable alarm to the international spinach industry.

#### Action

We have actively participated with the spinach industry stakeholders to address the downy mildew situation on spinach both in the U.S. and the E.U. Our laboratory has focused on developing near-isogenic spinach lines with specific resistance loci isolated in an otherwise susceptible genetic background to aid in the identification of races of the spinach downy mildew pathogen. Furthermore, the near isogenic lines being developed can be used to study the genetics of resistance to this important disease and for developing molecular markers linked to major genes for resistance.

#### Impact

As a result of this research effort, our laboratory has identified 8 of the 12 new races of the downy mildew pathogen worldwide and has developed a molecular marker linked to a disease resistance locus that can be used to expedite the selection process in breeding for disease resistance in spinach. The marker work was published in 2008 and has been picked up and utilized by a number of international vegetable seed companies.

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#### Funding

University of Arkansas Division of Agriculture

# Use of molecular and genetic tools to identify anthracnose pathogens of fruits and vegetables worldwide

#### Issue

Anthracnose diseases, caused by various *Colletotrichum* species, are economically important plant diseases worldwide. The taxonomic species which isolates belong to often is difficult to determine based on traditional taxonomic features. Accurate identification is critical as quarantine procedures affect various affected commodities are sold and shipped. Furthermore, accurate identification is important for implementing control procedures. A specific effort on pepper anthracnose has been initiated.

#### Action

Our laboratory has devoted considerable effort to characterize genetic and molecular diversity with a cosmopolitan species, *C. acutatum*. A geographically diverse collection of isolates from throughout the world from a wide range of hosts has been assembled. Molecular (AFLPs, mtDNA RFLPs, and intron sequences) and genetic markers (sexual and vegetative compatibility) have been developed to characterize inter- and intra-specific diversity.

#### Impact

As a result of this research effort, we can more clearly and objectively identify and differentiate closely related species. Also, we have identified a sexual stage of *C. acutatum*, which had not been known to exist. We have been able to demonstrate that this mating population occurs worldwide.

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#### Funding

University of Arkansas Division of Agriculture

# Molecular diversity of the rice blast pathogen and interaction between the resistance gene *Pi-ta* and the pathogen avirulence gene *AVR-pita*

#### Issue

The rice blast disease is one of the most important diseases of rice worldwide, including Arkansas. Obtaining knowledge about the genetic and virulence diversity of the pathogen population and how new races develop is critical to breeding for durable resistance into commercial rice cultivars.

#### Action

We have examined the genetic and virulence diversity of the rice blast pathogen population in Arkansas by collecting year blast samples and characterizing them for their DNA fingerprints and their ability to cause disease on a range of rice cultivars. In addition, efforts have focused on examining isolates that overcome a commonly used resistance gene *Pi-ta*. In addition, efforts have focused in transforming isolates of the rice blast pathogen by reintroducing a functional *AVR-Pita* gene back into isolates that have an ineffective functional gene.

#### Impact

We have characterized a large collection of rice blast pathogen isolates from throughout Arkansas and have determined that all isolates belong to 1 of 4 distinct fingerprint groups. However, 1 group, MGR586 Group A predominates. However, only isolates in MGR586 Group B apparently are capable of overcoming *Pi-ta* resistance by a modification of the corresponding *AVR-Pita* avirulence gene.

#### Contact

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#### Funding

University of Arkansas Division of Agriculture

# Impact of high night temperatures on rice yield and quality

#### Issue

High night temperatures often limit rice yield and quality In particular, head rice yields have been reduced by high night temperatures.

#### Action

Research to determine head rice yield responses to night temperature in both field and controlled climate conditions were conducted and a series of enzyme analyses were done to determine which enzymes might be related to the decreased head rice yield. In our experimental work, starch synthase had clear temperature optima for most varieties for 22 °C but the optimum was 26 °C for Bengal. In addition, Bengal and Cypress had little deleterious head rice yield response to high night temperatures while other varieties decreased head rice yield in response to high night temperatures. Consequently, there is some good reason to believe that the head rice yield response of Bengal is related to its higher starch synthase temperature optimum. In 2009, real time reverse-transcription polymerase chain reaction analysis of the tissue was done. These analyses indicated that the most commonly expressed isoform of starch synthase was SSIV-2. Starch synthase expression for Bengal and LaGrue was constant across all night temperatures in the study. Starch synthase expression for M-204 and Cypress was reduced for all four isoforms. Impact

Head rice yields are reduced annually by high night temperatures. Determining a genetic remedy to these reductions could increase farmers' values by significant amounts of dollars per acre. This work is a critical component for identifying genes conferring resistance to high night temperatures. Identification of these genes will allow breeders to put this knowledge to work in a practical way that improves rice milling quality.

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#### Funding

RiceTec, Alvin, Texas; Arkansas; University of Arkansas Division of Agriculture, Agricultural Experiment Station

### Predicting changes in the financial well being and payback histories of FSA direct loan borrowers

#### Issue

The Farm Service Agency makes direct loans to farm operators who are on the financial margin. Direct loans provide credit to financially stressed borrowers who are nonetheless creditworthy. The rationale behind the program is that there are imperfections in credit markets servicing farm borrowers. FSA seeks to have borrowers improve their financial characteristics so that these borrowers can graduate to conventional commercial loans. This graduation goal can only be achieved if borrowers improve their financial characteristics over the course of holding a direct loan and being successful in the overall farm enterprise. In addition to improving indicators of financial well being, it is important that borrowers establish a good payback history in their attempt to obtain conventional financing. Thus the numbers of delinquencies and loan restructurings are good indicators of borrower ability to service debt while strengthening farm financials. Also, the ability of FSA to make loans is constrained by Congressional appropriations for loan authority. By showing that loans are going to creditworthy farmers, the effectiveness of the program can be partially evaluated (there are many other factors that go into evaluating the overall effectiveness of the direct loan program). Also, by understanding how factors about the borrower known at time of loan origination can be used to predict the likelihood of strengthening borrower financials and having fewer delinquencies or restructuring, FSA can make the loan program more effective.

#### Action

University of Arkansas researchers teamed with a survey group and researchers at the Farm Service Agency to collect data on a sample of direct loan borrowers who closed direct one-year and seven-year operating loans during fiscal years 1994-1996. There was 90% response rate and the survey was nationwide. Included in the information gathered by Farm Loan Managers at the county office level were demographic characteristics of the borrowers as well as financial information on both borrower current financial situation as well as projected income. Most crucially, information was gathered on changes in the borrower's net worth and debt-to-asset ratio. These are two very important indicators of farm financial well being. In addition, data were gathered on how many loan restructurings and delinquencies the borrower experienced from October 1, 1996 until the time of the survey, November 2004. Since four distinct loan types were considered (operating loans (OL) of one or seven years maturity, farm ownership loans (FO) and emergency loans (EM)), four different models were estimated for each dependent variable: change in net worth, change in debt-to-asset ratio, number of restructurings and number of delinquencies.

#### Impact

The results were primarily as expected although some surprising results emerged. The mean annual change in net worth was \$9,097 and statistically significant at 0.01. Annual change in debt-to-asset ratio had a mean value of 0.065, also significant at 0.01. The increase in debt-to-asset ratio is unexpected because it indicates greater financial stress. FSA direct loan borrowers are typically younger than farmers in the general farmer population so an increasing debt-to-asset ratio likely signals using debt to increase the scale of operation. The sampled borrowers had average restructurings equal to 2.3 and delinquencies equal to 1.8. In general, the loan delinquency and restructuring models were superior to the change in net worth and change in debt-to-asset ratio models in explanatory power. The estimated financial change models showed that an independent variable's impact and significance varied by the loan type and whether the model was explaining changes in net worth or changes in debt-to-asset ratio. Increasing land values were positively correlated with OL borrowers' net worth. Limited resource loans had a significant impact on changes in borrower net worth-negative for OL loans and positive for FO loans. Debt-to-asset ratio change was negatively related to the debt-to-asset ratio at origination. This negative relationship of the initial debt-to-asset ratio may indicate that FSA and other creditors do not wish to make a marginal financial situation worse by increasing credit. Length of time in the FSA direct loan program had a positive impact on financial well being. The estimated loan servicing models generally found that net worth was negatively related to number of delinquencies. Number of EM loans at origination was significant for FSA borrowers. A larger number of existing EM loans at origination indicated a borrower who would be more challenged to pay back loans. FSA targets loans to socially disadvantaged and beginning farmers. The variables indicating a loan has an assistance code in one or both of these programs were almost always statistically insignificant, which implies these programs put such borrowers on an equal footing with borrowers not in these programs.

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#### Cooperators

This was a multi-institutional project that also involved

#### AAES Research Series 580

Charles B. Dodson and Steven R. Koenig of the Farm Service Agency, an agency of the USDA in the data collection phase and in understanding the FSA direct loan program. Diana M. Danforth, Sandra Hamm Martini and Aiko Landerito of the Department of Agricultural Economics and Agribusiness, University of Arkansas and Division of Agriculture were members of the research team.

#### Funding

This project was supported in part by Cooperative State research, Extension, and Education Service (CSREES) Award number 2004-39528-14478 between the Farm Service Agency and the Department of Agricultural Economics and Agribusiness at the University of Arkansas Division of Agriculture

# Economic decision making and planning guides for 2010 Arkansas field crop production

#### Issue

Farmers in Arkansas desire assistance and guidance in planning for field crop production. The primary objective of crop enterprise budgets is to assist producers in planning for crop expenses. Budgets include expenses and returns which are based on typical Arkansas yields and expected commodity prices. Coordination of budget development by crop enterprise enables producers to make decisions based on comparative costs and returns among crops. The Department of Agricultural Economics and Agribusiness at the University of Arkansas decided in 2009 to revise its crop enterprise budget program in order to provide improved service to producers and other constituents. The new crop enterprise budget program is intended to more effectively and efficiently meet the needs of clientele, as well as to expand the program for application in analyzing the crop production sector of the Arkansas economy.

#### Action

Methods employed for developing crop enterprise budgets include input prices that are estimated directly from information available from suppliers and other sources, as well as costs estimated from engineering formulas developed by the American Society of Agricultural and Biological Engineers. Analyses are for generalized circumstances with a focus on consistent and coordinated application of budget methods for all field crops. This approach results in meaningful costs and returns comparisons for farmer decision making related to acreage allocations among field crops.

In addition to printed budgets, the new program includes online interactive budgets. Producers can enter their production costs, as well as expected yields and commodity prices. This provides unique expected costs and returns calculated for base Extension production methods. A feature of the new budget program is to offer a service in which growers can request customized budgets for their operation.

#### Impact

Enterprise budgets are utilized by numerous participants in Arkansas crop production. Enterprise budgets contain information for others interested in the financial situation of Arkansas field crops. The new University of Arkansas budget program is intended to provide enhanced planning services to producers and to better inform all stakeholders of Arkansas agriculture.

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#### Cooperators

Faculty and staff in the Department of Agricultural Economics and Agribusiness, as well as the Department of Crop, Soil, and Environmental Sciences participate.

#### Funding

University of Arkansas Division of Agriculture

# Diversifying the genetic base of Arkansas rice

#### Issue

Recent studies have documented a decline in genetic diversity of modern cultivars. For example, the genetic base of Southern U.S. rice was found to be limited to 22 ancestral lines. Lack of genetic variation limits possibilities for breeding advancement especially in biotic and abiotic stress resistance. Continued development of improved rice cultivars is imperative in order to meet changing cultural and marketing conditions in Arkansas.

#### Action

U.S. rice cultivars set the standard for quality in long and medium grain world trade. Arkansas rice producers provide funding to help support research and extension to continue the advances made in sustainable production of top quality Arkansas rice. Cooperation with state, regional, and international rice breeding programs provides a source of new germplasm and data to help in evaluation and enhancement of Arkansas breeding efforts. The incorporation of novel rice germplasm into Arkansas cultivars requires careful characterization of the new introductions. Plant pathology, entomology, cereal chemistry and plant nutrition are taken into account prior to programming crosses. Genetic analysis using molecular marker technology will improve efficiency of gene incorporation. Field evaluation of advanced experimental lines is required prior to release of new cultivars, coupled with recommended management practices. At least 7 to 10 years are required to develop and release a new cultivar.

#### Impact

New Arkansas rice cultivars account for about \$66 million dollars a year in monetary gain. Semidwarf cultivars are grown on about 40% of Arkansas rice acreage. Locally adapted semidwarf long and medium grain cultivars incorporating novel germplasm can be expected to sustain this impact while helping to minimize producer's costs due to added inputs such as pesticides.

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#### Funding

University of Arkansas Division of Agriculture, Arkansas Rice Research and Promotion Board, USA Rice Federation

# Role of salicylic acid in plant defenses against aphids

#### Issue

Aphids are small, soft-bodied insects that feed on plant sap, depleting plant nutrients, manipulating plant growth, and potentially transmitting plant diseases. Nearly all major crops world-wide are attacked by aphid species. Therefore, a major goal of our research is to identify mechanisms of plant defense against this damaging group of insect pests. We recently identified a mutation in tomato that enhances aphid resistance by disrupting function of a plastidial  $\omega$ -3 fatty acid desaturase, FAD7. To investigate how and why loss of function of FAD7 decreases aphid infestations, we explored the role of salicylic acid because our preliminary data suggested that defects in FAD7 might enhance production of this hormone.

#### Action

We used high performance liquid chromatography to measure salicylic acid accumulation in response to feeding by aphids in both mutant and wild type plants. In addition, a transgene that suppresses salicylic acid accumulation (the *NahG* transgene) was introduced into an aphid-resistant mutant line of tomato to determine if reduction in salicylic acid levels would also reduce aphid resistance. Our results indicated that accumulation of salicylic acid in response to aphid feeding is enhanced in the mutant line compared to wild-type plants. Further, introduction of the *NahG* transgene, which suppresses accumulation of salicylic acid, can make the aphid-resistant *fad7* mutants as susceptible to aphids as the wild-type plants.

#### Impact

These results strongly suggest that loss of function of FAD7 confers aphid resistance by increasing the salicylic acid-dependent defenses against aphids. In addition to shedding light on the hormonal control of aphid resistance, this work has important implications for our understanding of salicylic acid signaling. Salicylic acid is an important contributor to plant defenses against pathogens, and recent evidence suggests that fatty acids influence salicylic acid desaturase FAD7 corroborate those recent reports, and may help pinpoint which fatty acids are key regulators of salicylic acid signaling.

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#### Funding

Plant Powered Production (P3) Center through the RII Arkansas ASSET Initiative (AR EPSCoR), funded by NSF grant # EPS -0701890; University of Arkansas Division of Agriculture

# Alternative to insecticides prevents defoliation by Japanese beetles

#### Issue

The Japanese beetle is a recent invasive species to Arkansas. This beetle is causing severe damage to foliage, flowers and some fruits produced by fruit growers, plant nurseries and owners of landscape plantings.

#### Action

Japanese beetle management practices were demonstrated in two fruit plantings. From late June to mid July, foliage and fruit in four rows of a commercial 'Norton' grape vineyard and a row of organically produced 'Enterprise' apples were kept white-washed with foliar sprays of Surround (processed kaolin clay mined in Georgia). Adjacent rows of grapes were treated weekly with registered insecticides. Heavy rainfall required reapplying Surround. Later, we counted the number of Japanese beetles on each treated vine and compared the foliar damage among treatments.

#### Impact

Surround white-washing of foliage provided acceptable fruit plant protection comparable to that achieved by weekly foliar insecticide sprays of adjacent fruit plants. Over 100 fruit growers that attend the Wine and Grape Conference or Oklahoma and Arkansas Horticulture Industry Show will learn about this tactic of white-washing with Surround to prevent defoliation by Japanese beetles.

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Cooperators

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#### Funding

Missouri Wine and Grape Research Board; USDA Integrated Organic Program; Organic Farm Research Foundation; Bumpers College of Agricultural, Food and Life Sciences; University of Arkansas Division of Agriculture

# Alternative to insecticides prevents leaf galling by grape phylloxera

#### Issue

Grape growers in Arkansas and many other states are shifting grape production to include more hybrid wine cultivars. Many of these grape cultivars were hybridized from grape parents of French *Vitis vinifera* and American *Vitis* species. These hybrid cultivars are susceptible to severe foliar leaf galling by grape phylloxera, which reduces photosynthesis leading to reduced fruit quality and yield.

#### Action

From May to late June, we inspected expanding terminal grape leaves weekly looking for new immature galls caused by newly emerged, grape phylloxera crawlers. The underside of newly infested leaves appear bumpy or rash-like as a gall forms around each crawler. A  $10 \times$  magnification hand lens was used to scan these leaves for grape phylloxera. Once crawlers were detected, we applied foliar treatments of either registered insecticides or white-washed the foliage with Surround (processed kaolin clay mined in Georgia). The goal was to maintain a white-wash appearance of the foliage. Later, we compared the number of shoots with galled leaves per vine for each treatment.

#### Impact

Insecticides and Surround foliar sprays were accurately timed to prevent significant grape phylloxera leaf galling. The current recommendation is for grape growers to delay foliar sprays of registered insecticide or Surround until they see grape phylloxera crawlers on expanding terminals leaves of susceptible cultivars.

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#### Funding

Missouri Wine and Grape Research Board; Viticulture Consortium-East; Bumpers College of Agricultural, Food and Life Sciences; University of Arkansas Division of Agriculture

## Identification of creeping bentgrass cultivars adaptable for use by Arkansas golf course managers and developers

#### Issue

Management of a bentgrass putting green is the most timeconsuming, costly, and difficult aspect of golf course management in Central and Northern Arkansas. This project identifies creeping bentgrass cultivars adaptable for use by Arkansas golf course managers and developers. Selection of the proper cultivar, and identifying best management practices for this growing region, will make a significant long-term impact on golf course management in the state. Furthermore, improved putting green health may be achieved by identifying practices that maintain acceptable putting quality. Such practices include increasing mowing heights or decreasing mowing frequency, when combined with putting green rolling. Finally, improving summer stress and summer disease tolerance may be achieved by indentifying management practices that improve moisture distribution in sand-based putting greens, such as wetting agent application.

#### Action

Identification of adapted cultivars: Evaluations of 19 cultivars are being conducted at the Fayetteville research station. The National Turfgrass Evaluation Program is responsible for funding replicated cultivar trials around the country and has awarded the University of Arkansas a trial for 2009-2013 evaluations. Tests are being conducted on USGA-specified putting greens and native soil fairways and maintained for a period of 5 years.

#### Impact

Putting green cultivars that are best adapted to this region are being identified and that information is communicated to golf course superintendents through channels such as field days, research reports, conference presentations, and personal communication. A local, high-end golf course has used data from this project to select a cultivar when renovating their golf course. Similarly, other regional golf courses are likely to use data from this project when selecting cultivars when renovating putting greens, which will eventually lead to better adapted putting green cultivars throughout Arkansas that should require fewer management inputs. Also, preliminary data from the mowing and rolling, and wetting agent study components of this project have been communicated to regional golf course superintendents through similar channels as the cultivar data. As a result, many golf course superintendents have altered their putting green management strategies to produce high quality greens with reduced mowing and/or irrigation inputs.

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#### Funding

University of Arkansas Division of Agriculture National Turfgrass Evaluation Program Golf Course Superintendents Association of America

# Impact of nematodes and seedling diseases on cotton production and profitability

#### Issue

Cotton is an important crop in the southern U.S. with an estimated annual value of \$6 billion. A significant constraint to profitability in Arkansas is yield suppression due to the root-knot nematode and black root rot of seedlings caused by *Thielaviopsis basicola*. The estimated monetary loss to cotton farmers in our state last year to diseases was slightly over \$300 million, and a major proportion of this loss was due to nematodes and seedling diseases. Both pathogens produce characteristic morphological changes in infected roots, and both alter the size and shape of the root systems of infected plants. The degree to which these pathogens affect cotton plant development and yield performance and the influence of certain edaphic factors such as soil texture or soil compaction is not well defined. There are no commercially acceptable nematode or black root rot-resistant cotton cultivars available for use in this region, but chemical nematicides and fungicides are available. These materials range in cost from \$25-\$45 per acre annually.

#### Action

The efficiency with which nematode-infected cotton roots utilize nitrogen fertilizer is being investigated in field plots in southeastern Arkansas. Growers in this region have historically needed to "over-fertilize" relative to CES fertility guidelines in order to maintain their target production levels. However, when nematicides such as Telone II are applied, excessive plant growth is many times a problem when these levels of nitrogen fertilizer are applied. Our studies are aimed at quantifying the role of nematodes in nitrogen fertilization programs in the region with the objective of determining if judicious nematode management may allow a decrease in the amount of nitrogen fertilizer that is needed for profitable cotton production. Additional studies that have just been initiated both in microplots and in field plots are being conducted to i) quantify and describe the changes in cotton root system architecture that result from infection by root-knot nematodes and the black root rot pathogen singly and in combination and ii) determine the impact of increased soil bulk density (compaction layers) on nematode and black root rot severity and cotton yield and development.

#### Impact

An understanding of the impact of nematodes and seedling diseases on root efficiency and architecture will clarify the importance of these pathogens in cotton production and profitability. When these effects are quantified, we should be able to develop more effective strategies both for nematode and disease management and fertilizer management in cotton in Arkansas.

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#### Funding

Arkansas Cotton State Support Committee (Cotton, Inc.); University of Arkansas Division of Agriculture

## Providing soybean producers with criteria to select an appropriate resistant cultivar

#### Issue

Two important criteria for selection of soybean cultivars for planting by Arkansas farmers are: i) yield potential and ii) disease resistance. The Arkansas Official Variety Testing program (OVT) for soybean cultivars is conducted each year to evaluate the yield performance of new varieties, with the objective of estimating their yield potential under our environmental conditions. The program has been very successful in providing timely yield data to Arkansas growers, but because this program is designed to compare yield performance among cultivars in the absence of diseases, resistance is not measured.

#### Action

Our comprehensive annual program evaluates all cultivars in the OVT each year for resistance or susceptibility to an array of our most common disease and nematode pests. This program utilizes inoculated field nurseries and greenhouse tests to evaluate the potential risks from soybean stem canker, frogeye leaf spot, aerial blight, root-knot nematodes, soybean cyst nematodes, and reniform nematodes. The information is accumulated during the growing season and made available to growers, advisors, extension personnel, and the soybean industry through websites for immediate access where it becomes the backbone of the CES Annual Soybean Update and the SOYVA computer assisted cultivar selection program.

#### Impact

In 2009, Arkansas produced soybeans on about 3.2 million acres. Estimates of yield losses in Arkansas are around 17% annually according to recent surveys by the Southern Soybean Disease Workers. At least half of these losses could have been prevented simply by selecting an appropriate resistant cultivar, resulting in about 10 million additional bushels of soybeans for sale by our soybean producers last year

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#### Funding

Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture

### Development of the Arkansas Center for Plant-Powered Production "P3"

#### Issue

Plant-based agriculture represents a major economic force for the state of Arkansas, and success in plant research is vital to continued growth in this arena. Although researchers in plant biology are active at institutions across the state, there was previously no formal way to connect scientists and efficiently forge collaboration. Sustained investment in research infrastructure improvement is a key component of thriving research programs, which can ultimately translate into both technological and commercial advancements.

#### Action

With the goals of enhancing research infrastructure and

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inter-disciplinary, multi-institutional collaboration, we have established the Arkansas Center for Plant-Powered Production (P3). Rapid growth of the P3 Center has been made possible via funding from the National Science Foundation Experimental Program to Stimulate Competitive Research (NSF-EPS-CoR) with matching support from the state of Arkansas. Division of Agriculture scientists from the University of Arkansas Fayetteville campus have developed collaborative projects with researchers at Arkansas State University/Arkansas Biosciences Institute in Jonesboro, and at University of Arkansas-Little Rock. The P3 is focused on making researchers more competitive, as they explore new uses for plants as medicines, healthy foods, fuels, and industrial compounds. In addition, technologies are being developed addressing scale-up and complexity of production of plant-based goods. Direct support to plant scientists has been made available thru collaborative seed grants, capital equipment purchases, and funds for professional development.

#### Impact

The P3 Center represents a new direction for Arkansas plant scientists, which builds on the state's strength in agriculture and the food industry, and on recent investments in research at the interface of agriculture, the environment, and medicine. Competitive success of researchers in the Division of Agriculture can translate into new field applications for plants as food, fuel and fiber, and ensure that plant-based agriculture continues as an important contributor to economic development.

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#### Funding

National Science Foundation-EPSCoR; State of Arkansas; University of Arkansas Division of Agriculture

# Recovery of new biological control agent in Arkansas

#### Issue

Habitats in Arkansas continue to be threatened by spread of invasive species. Spotted knapweed (*Centuarea stoebe* ssp. *micranthos*, Asteracae) is an exotic weed that has invaded northern Arkansas and has spread aggressively in the past decade. The weed displaces desirable forage and makes invaded pastures less valuable, as cattle avoid feeding on the weed. Spotted knapweed is managed using biological control agents (insects that attack knapweed) in the northern U.S. Only one of the 12 biological control agents introduced to the U.S. occurs in Arkansas. This agent, a seed-feeding fly, *Urophora quadrifasciata*, was found to have more generations and destroy more seeds than in northern states. However, the fly also does not reduce seed numbers or induce enough plant damage to decrease weed spread, due to the longer growing season in the south. To implement a knapweed biological control program in Arkansas, we released a new natural enemy, *Larinus minutus*, the flower head weevil, in 2008 and 2009.

#### Action

We determined that two other biological control agents, the flower head weevil *Larinus minutus* and the root weevil *Cyphocleonus achates*, hold promise to combat knapweed in Arkansas. In July 2009, *Larinus* adults were redistributed to a field nursery in the Arkansas Ozarks. Samples collected in the summer of 2009 at release sites verified that the flower head weevil successfully reproduced and overwintered. This is the first recovery of this species from the southern U.S. and confirms its establishment. Further releases of the weevil were made in 2009 at 6 additional locations in northwest Arkansas. Establishment and spread from release sites are being tracked. The impact on knapweed populations is being evaluated using plant stand counts, photographic evidence and GIS.

#### Impact

Redistribution of biological control agents against spotted knapweeed is advised because the seed-feeding fly alone has not reduced knapweed populations or stopped its spread. Redistribution of the two weevils into Arkansas, starting with the flower head weevil, gives the best option for biological control of the weed. We expect that successful biological control will reduce herbicide use for this rapidly expanding weed while minimizing introduction of other agents. Tools that are developed to track the impact of these agents on knapweed populations at the local and regional levels will also be useful in other terrestrial weed biological control programs in Arkansas.

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USDA-APHIS-PPQ; University of Arkansas Division of Agriculture

# Arkansas growers produce record yields growing blast-susceptible rice varieties

#### Issue

Historically, the unpredictable blast disease has frequently devastated rice crops with 100% yield loss observed in very susceptible varieties. Rice blast is primarily controlled using resistant varieties, cultural practices, and fungicides. The most obvious and widely recognized form of variety resistance occurs when one or more major resistance genes (R-genes) confer immunity to the blast disease. Unfortunately, R-gene varieties are often quickly overwhelmed by new and/or unexpected variants of the rice blast pathogen, Magnaporthe grisea. In contrast, a more sustainable rice blast field resistance is available through the combined action of multiple major/ minor resistance genes. Field resistance allows the plant to become diseased and is adversely impacted by field conditions. When rice blast is controlled, modern susceptible varieties typically out-yield R-gene resistant varieties by five to ten percent. Growers can alter various cultural practices to lessen

the occurrence and impact of diseases. Fungicides, often not efficacious, are expensive and are difficult to utilize requiring exacting application technology.

Arkansas rice growers and scientists long observed extensive blast damage in plants growing under dry-land conditions, such as on the tops of levees and in higher areas of a field with inadequate soil moisture. Conversely, nearby plants of the same variety growing in the flooded parts of the paddy were healthy or significantly less damaged than the drought stressed plants growing upland.

#### Action

Field observations were documented by research into proper water management practices. A continuous deep flood was determined to be an effective blast control strategy in susceptible varieties. In addition, proper cultural practices including the water management techniques serve as tools for rice breeders when selecting for new varieties and germplasm with increased blast field resistance.

Continued research into mechanism of flood induced field resistance has identified root zone dissolved oxygen (DO) as the mediating variable for blast field resistance mechanisms. DO content defines availability of plant nutrients and root production of hormones, primarily ethylene, which determine susceptibility to rice blast.

#### Impact

Research scientists have manipulated this knowledge to prevent or greatly reduce the incidence of rice blast in Arkansas and to select new varieties with even higher levels of field resistance. The rice variety Taggart serves as an excellent example of increased blast field resistance in susceptible varieties. Taggart, with significantly higher blast field resistance, should replace the Wells and the Francis varieties currently preferred by Arkansas producers.

Grower acceptance of recommended fertility, irrigation and disease scouting practices based upon these scientific concepts and results have reduced disease incidence and severity.

Proper irrigation procedures are the primary blast control strategy utilized by Arkansas growers and is now accepted as an efficacious blast control by rice research scientists in the U.S. During blast conducive years 2001-2009, Arkansas rice growers used flood management and other cultural practices, to produce record or near-record per acre and statewide rough rice yields growing very-high-yielding, blast susceptible varieties. When grown blast disease free, the susceptible cultivars yield 5 to 30 more bushels of rice per acre than available R gene resistant varieties. At an estimated value of \$5 per bushel, this additional yield provides approximately \$25 to \$150 increased per acre income in over 80 percent of Arkansas rice acres. A production cost reduction of \$35 to \$70 per acre is realized from reduced fungicide use which in turn lowers the pesticide load on the environment.

By its parasitic nature, the blast fungus must adapt by evolving new races to overwhelm R genes. Apparently, there is less pressure to evolve new races with field resistant varieties when growing in flood conditions. As a result, the erratic nature of the disease has been moderated in Arkansas.

In addition, long-term benefits will accrue as plant breed-

ers utilize the research to develop even higher yielding field resistant varieties.

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#### Funding

University of Arkansas Division of Agriculture and Arkansas Rice Research and Promotion Board

### Dynamic rice diseases demand diligence

#### Issue

Rice diseases are difficult and expensive to manage. Many disease-causing fungi, such as the rice blast pathogen *Magnaporthe grisea*, easily adapt to attack disease resistant varieties. Research is required to monitor rice diseases and develop effective disease management programs using combinations of genetic resistance, cultural practices and fungicides.

#### Action

Arkansas rice pathologists routinely evaluate newly acquired germplasm of *Oryza sativa* and related *Oryza* sp. in an effort to identify and define new disease resistance genes. Existing and novel desirable genes are utilized by plant breeders to develop improved varieties. Rice pathologists define existing resistance genes and discover novel resistance genes, provide research data about the optimum cultural practices necessary for disease control in susceptible varieties and to extend utility of available resistance genes. Arkansas rice varieties have excellent yield potential in the presence of the state's two most costly diseases - sheath blight and blast. Researchers continually test and verify recommendations for managing diseases using resistant and susceptible varieties, proper cultural practices and, as a last resort, fungicides.

#### Impact

Using high-yielding, disease-resistant Arkansas rice varieties, rice growers produce record rough rice yields while reducing production costs by as much as \$70 per acre by eliminating the need for costly fungicides. Producers also are provided the technology necessary to manage disease-susceptible varieties having very high yield potential when diseases are controlled.

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#### Funding

University of Arkansas Division of Agriculture and Arkansas Rice Research and Promotion Board

# Pine straw harvesting and soil sustainability in loblolly pine stands

#### Issue

Pine straw is an important landscaping commodity in the Southern United States. Pine straw can be annually harvested in Arkansas loblolly pine stands by raking and baling of fallen pine foliage from the forest floor. Although the removal of pine straw can provide additional income to landowners, it also removes important nutrients and organic matter from the soil that may alter nutrient availability and thus reduce timber yields from these plantations.

#### Action

Researchers within the Arkansas Forest Resource Center and the Louisiana State University AgCenter collaborated to address this issue within a broad region of the Upper Gulf Coastal Plain of Arkansas and Louisiana. Researchers evaluated the effect of seven years of pine straw removal on soil nitrogen availability in a loblolly pine plantation located at the Louisiana State University, Calhoun Research Station (Calhoun, La.). Additionally, they evaluated whether any alteration in nitrogen availability could be remediated by fertilizer additions. Equivalent additions of nitrogen in poultry litter and inorganic fertilizer were compared to evaluate which fertilizer would better replace any nitrogen losses occurring from the pine straw harvesting.

#### Impact

This study indicated that although rates of nitrogen mineralization in the areas with pine straw harvesting were similar to that in areas without pine straw harvesting, there was 21% less available nitrogen in the soils where pine straw was harvested. This reduction of available nitrogen appeared to be directly related to a loss of available nitrogen supplied to the mineral soil by the pine straw and forest floor. Five years of application of either poultry litter or inorganic fertilizer was able to replace the lost available nitrogen. However, the added nitrogen from poultry litter was retained to a greater degree than that from inorganic fertilizer. Potentially, the lost nitrogen could be replaced by lower application levels of poultry litter than inorganic fertilizers.

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#### Funding

USDA Hatch Funds; Louisiana State AgCenter; University of Arkansas Division of Agriculture

# Quarantine treatment of commercial grass sod

#### Issue

Arkansas grows about 9,000 acres of sod each year and has approximately 58 sod producers. The majority of grass sod in Arkansas is grown within the area designated as quarantined due to infestation by imported fire ants. Because of the quarantine, sod producers are required to treat sod-at a considerable cost-before shipment into non- infested counties or out of state. Insecticide options for fire ant quarantine treatment are very limited, expensive and often require long exposure periods. Registration of chlorpyrifos as a fire ant quarantine treatment option in commercial sod production has been withdrawn. The one remaining option for this use is fipronil, which is expensive and requires a long exposure period. However, the conditional registration for use of fipronil on sod and turf expired and the product may not be re-registered. The potential loss of this one option for Arkansas sod producers requires discovering and testing other options.

#### Action

We continued studies to identify alternative treatment options for fire ants that infest commercial sod. The objectives were to find more economical and practical insecticide options for commercial sod producers to use to meet federal and state requirements to ship sod from quarantined areas. Our results identified bifenthrin was an acceptable quarantine treatment. We also found that treatments that combined baits and bifenthrin may also be suitable. The combination treatment would be less expensive than treatment with bifenthrin alone and would result in a shorter exposure period, thus providing a better option for Arkansas sod producers. Additional studies with combination treatments are planned for 2010.

#### Impact

The Arkansas State Plant Board used our study results to approve use of bifenthrin as a quarantine treatment option for within-state quarantine treatment of sod. Our results will also likely lead to approval of bifenthrin by USDA in 2010. Sod producers in quarantined areas are required to treat sod before shipment into non-quarantined areas. The cost of the bifenthrin treatment is approximately \$84.00 per acre verses about \$600.00 for the current insecticide option. Thus, producers shipping sod from IFA quarantined to non-quarantined areas will save approximately \$500.00 per treated acre, and help stop the spread of fire ants into non-quarantined areas.

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USDA-APHIS, FMC Corporation; University of Arkansas Division of Agriculture

# Understanding field resistance to *Bt* toxins in the bollworm

#### Issue

For several years, entomologists with the Division of Agriculture have tracked and reported variable response of populations of bollworm, Helicoverpa zea, to the Bacillus thuringiensis-derived toxins expressed in transgenic corn and cotton varieties (Bt crops). This research has been a collaboration with scientists from the USDA and agricultural industry. The work addresses EPA-mandated resistance management requirements for continued registration of these transgenic crops. The large dataset generated from these studies has attracted the attention of other scientists, especially population geneticists interested in the evolution of Bt resistance genes in insects. Statements by some scientists that used our data concluded that bollworm evolved resistance, which has created a national debate about the impact of variable laboratory results on population traits of bollworm in the field. There is a need for research to better relate or define the relationships between laboratory assays and actual genetic traits of insects in the field.

#### Action

Bollworm populations were established from collections made on Bt corn at four locations in Arkansas. Detailed observations were made on survival, generation time and reproductive capacity of each individual larva. Laboratory populations were created by inbreeding the field-collected larvae and crossing field-collected insects with a susceptible laboratory strain. Progeny of these crosses were also monitored for survival, development and reproductive capacity, and different cohorts were exposed to diet and plant assays to relate the diet-assay data to projected survival on field grown conventional and Bt cotton. Inbred colonies from the field had strong reproductive fitness costs, suggesting that the earlier dataset may have under-estimated the frequency of some resistance genes in bollworm populations. Survival of progeny of some laboratory colonies on Bt cotton confirmed that the insects have genetic capacity to survive exposure to the Bt toxins in the field and can successfully reproduce. Relationships between diet assay results and plant assay results were not strong, suggesting a greater need for plant-based assays for accurate monitoring of resistance, and better definition by scientists of what constitutes field resistance.

#### Impact

Our results will help growers manage bollworm in a changing agricultural landscape, and help scientists define how to monitor resistance and how to relate lab assays and projections in the field. From a practical management perspective, insects exposed to *Bt* crops take longer to develop, which reduces the numbers of generations of bollworm in Arkansas. In locations with large acreages of cotton, expanded planting of new *Bt* corn hybrids may significantly impact populations of this polyphagous insect. Options for growing conventional cotton—especially early-maturing cotton—in an environment of increased corn acreage, may be possible if the impact on bollworm populations by new *Bt* corn hybrids is similar to

that by *Bt* cotton, and if growers optimize crop development through management and monitoring of harvestable fruit.

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#### Funding

University of Arkansas Division of Agriculture

# Projecting spring emergence of pecan nut casebearer and infestations on Arkansas pecan

#### Issue

The pecan nut casebearer, *Acrobasis nuxvorella*, is a key pest of commercial pecan across the U.S. Pecan Belt. Population levels in Arkansas probably vary from annual, large infestations in southwestern Arkansas to rare, small infestations in northeastern Arkansas; however, accurate data are lacking. Effective pheromone traps systems have been developed over the past decade to effectively predict activity of the first spring generation of moths and time insecticide sprays to protect the small nutlets in May and June from larval entry and nut loss. The first generation is the most damaging as a single larva can cause the loss of an entire cluster of the small nutlets.

#### Action

Prior to spring emergence of pecan nut casebearer adults, commercial orchards and native groves of pecan were sampled for the presence of overwintering hibernacula. Hibernacula are small structures of insect silk and plant parts that serve as an overwintering site for larvae from the last generation of the previous year. A network of 139 pheromone traps was established across Arkansas, including sites in Little River, Miller, Chicot, Conway, Pulaski, Phillips, White, Johnson, and Washington Counties, as well as Bowie County, Texas. Traps were checked for pecan nut casebearer activity at least three times per week during May and June. Observations were made by cooperating extension agents and growers. Data were reported via telephone answering system to a Division of Agriculture laboratory at the University of Arkansas. A website (http://comp.uark.edu/~miali/PNC/report.html ) was created to update the Arkansas growers about moth activity and need for insecticide sprays, and all work was coordinated with an ipmPIPE project across the U.S. Pecan Belt, administered through Texas A&M University ((http://pecan.ipmpipe.org/).

#### Impact

Hibernacula were observed in both managed orchards and native groves, indicating that this overwintering stage of the insect may be a good indicator of resident populations across the state. Densities of moths in southwestern Arkansas were very high and pecan nut casebearer populations were

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confirmed along the Arkansas River in central Arkansas. No significant moth captures were made in Craighead, White and Phillips Counties, but moths were captured in Chicot County. The communication network with extension agents and growers stimulated additional interest in coordinated research on pecan insects in Arkansas. The contributions from Arkansas to the ipmPIPE project were noted and additional study of this native insect is important in Arkansas.

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Collaborating County Agents: John Turner, Wayne Smith (Bowie County, Texas), Gus Wilson, Robert Goodson, Sherri Sanders and Steve Culp.

Field Scouts: Ibrahim Ali, Dan Chapman, Rose Ann Farewell, Candice Cantwell, Bennie Tillis, Cody Gallagher.

#### Funding

University of Arkansas Division of Agriculture; USDA-CSREES E-IPM Program, ipmPIPE Project on Pecan Insects

# Synthesis and development of new herbicides for control of resistant barnyardgrass in Arkansas rice

#### Issue

Some populations of barnyardgrass, which is a major weed in rice production, have developed resistance to the herbicide clomazone (Trade name Command®). Control of this weed is necessary to maintain high yields of rice in Arkansas.

#### Action

We have found that a hydrolysis product of a metabolite of clomazone is effective as a herbicide against both the normal population of barnyardgrass and the clomazone-resistant population. It is also phytotoxic to some other weeds. We plan to test this compound further and synthesize other compounds with similar structures and test them for herbicidal activity.

#### Impact

This compound or analogs we synthesize may be effective as herbicides against barnyardgrass in rice or other crops. It may also be effective against other weeds.

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#### Funding

University of Arkansas Division of Agriculture

### Selection and evaluation of novel bald cypress germplasm for landscape performance

#### Issue

Ecotype provenance is an important concept when selecting plant germplasm for potential landscape use. A particular plant species may grow natively over a wide geographical region spanning several climatic or physiographic zones. For instance, Bald Cypress is native to riparian areas over a wide area of the eastern United States ranging all along the Atlantic Coast to the upper Mississippi River Valley west to eastern Oklahoma to south Texas extending in to Mexico. However, regional or even local variation exists in adaptability to drought, salt stress, cold tolerance, and soil pH along with varying growth form, habit, and fall color development. Most commercial liner production or propagation of Bald Cypress is localized in a few locations in the eastern U.S. and propagule material (seed and cuttings) are locally obtained or haphazardly collected with little thought to ecotype provenance. This lack of provenance selection manifests itself when this plant material is transported and planted in other areas of the country with differences in soil pH, salt exposure, poor water quality or temperature extremes varying from the area of propagule collection. This leads to poor or failed landscape performance requiring frequent tree replanting or inordinate amounts of post planting care and resources thereby promoting an unsustainable landscape system. Research was initiated to develop plant material adapted to regions with greater climatic or physiographic variation to increase tree transplant success and subsequent landscape performance.

#### Action

Bald Cypress germplasm (seed) was originally collected over a wide range of ecosystems ranging from northern Mexico through central Texas and along the Gulf Coast to the Florida Panhandle. Previous screening identified 20 family lines with superior landscape potential. Traits initially screened included drought tolerance, tolerance to high soil pH, poor water quality (high sodium content, alkalinity) and general plant habit. Replicated plantings of these 20 selections were planted out at the Division of Agriculture Research Farm in Fayetteville, Ark., to further evaluate climate tolerance, adaptability to state and regional soils and overall landscape performance including growth rate, overall form, and fall color development. Evaluations will continue for 3 years to access overall landscape establishment and performance.

#### Impact

The results of one year evaluations in the field indicate differences in growth rates among the various germplasm lines. Differences in plant habit and form are also beginning to develop even after one year in the field. Canopy leaf color of medium to deep green of all selections was satisfactory indicating no chlorosis development due to problems with plant adaptability to local soil pH. Cold tolerance is currently being evaluated. Preliminary data indicate differences in growth rate and habit among the various selections. Further data collected on cold tolerance and ongoing growth rates and plant habit will allow for final selections to be made with future releases for tree production for landscape utilization.

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#### Funding

University of Arkansas Division of Agriculture

### Development and implementation of IPM programs for insects on Arkansas vegetables

#### Issue

Insects severely affect the more important commercially produced vegetables in Arkansas, including snap bean, squash, egg plant, spinach, greens and cowpea. Management of insect pests has been based on chemical insecticide applications delivered when plants reached specific developmental stages. Snap beans were sprayed at first bloom and every week thereafter; spinach received an insecticide application when plants were in the 2-inch rosette; and cowpea seedlings were sometimes sprayed when damage appeared, regardless of presence of insects. Although insecticides were repeatedly applied to squash for squash bug management, little control was obtained. Little to no effort at scouting for insects was made in Arkansas vegetable crops. As a result, insecticides were applied when no insects were present or when the least susceptible insect stages were present. That approach was costly in several regards, including costs of chemicals (\$5 to \$10 per acre) and application (\$3 to \$5 per acre), applicator exposure to chemicals, potential environmental hazards, and the potential for insects to develop resistance to synthetic chemicals. Multiple applications per season increased these costs further.

#### Action

Application of acephate has been shown to reduce thrips in cowpea blooms and increase the number of flowers per plant. Application of acephate or imidacloprid to cowpea seeds can reduce grower costs and provide excellent insect management. Studies have documented the biology and dynamics of the tobacco thrips on seedling cowpea and have shown that seedling thrips do not significantly reduce cowpea yield. Sampling techniques and thresholds have been developed and are currently in use for corn earworm larvae. Studies have also produced a method to detect of European corn borer larvae in snap bean seedlings and to use pheromones for adult European corn borers. These combined insect monitoring strategies are now used in decision making for insecticide application in all snap bean produced in the three-state area of Arkansas, Oklahoma and Missouri.

#### Impact

Results of these studies improve management of insects, reduce costs to growers and reduce human and environmental hazards from insecticide applications. Alternatives to foliar insecticide sprays for aphid management on spinach are now in use in the Arkansas River Valley. Strategies are being used to efficiently manage the corn earworm and European corn borer in spring snap bean in the three-corner region of Arkansas, Missouri and Oklahoma. Producers using these strategies have reduced insecticide use by about 40% with no reduction in snap bean quality.

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#### Funding

Allen Canning Co., IR-4 Program of EPA; University of Arkansas Division of Agriculture

### Managing head blight disease of wheat

#### Issue

Head blight, caused by the fungus *Fusarium graminearum*, threatens wheat production and utilization nationally and worldwide. Although head blight reduces yield, the major concern related to this disease is the level of associated mycotoxins in harvested grain. Deoxynivalenol is the toxin most commonly associated with affected wheat grain, but a strain of the pathogen that produces nivalenol rather than deoxynivalenol has been found in Arkansas and elsewhere. Nivalenol is approximately ten times more toxic to animals than deoxynivalenol. The worldwide trend has been to require lower levels of mycotoxins in grain to protect human and animal health, and achieving these lower levels will require greater efforts to manage head blight.

#### Action

The UA Wheat Pathology Program contributes to the national effort to manage this disease by developing germplasm lines with resistance that is not in the soft red winter wheat gene pool, evaluating breeding lines and cultivars for resistance, characterizing resistances that appear to be most useful, collaborating to investigate the phenotypic and molecular variation of the pathogen population, evaluating chemical control strategies, developing integrated management strategies, and disseminating information on best management practices to stakeholders. The Program also established working relationships with European scientists who have similar interests.

#### Impact

Growers are now able to select cultivars with moderate resistance to head blight, to obtain real-time head blight forecasts via the internet, and to use moderately effective fungicides when head blight threatens their crop. More efficient and accurate methods of screening lines for resistance were developed that are facilitating the development of resistant cultivars. Investigations of the phenotypic and molecular variation of the pathogen have led to a better understanding of the risk of nivalenol contamination of grain. Diverse sources of resistance used in the soft red winter wheat gene pool were shown to be effective against strains of the pathogen producing either deoxynivalenol or nivalenol, indicating that cultivars developed for resistance to head blight will be effective against both strains of the pathogen. A graduate student has been educated to conduct research on this disease.

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#### Cooperators

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#### Funding

U.S. Wheat and Barley Scab Initiative and University of Arkansas Division of Agriculture

# Arkansas rice variety improvement program

#### Issue

Arkansas farmers produce more than 45 percent of the rice grown in the United States under dynamic production conditions that differ from those in other rice-growing areas. Because of their prominence in this crop, Arkansas rice farmers depend on an Arkansas variety development program that provides a progression of improved varieties to meet the challenges of changing conditions in their fields and in the marketplace for rice.

#### Action

Arkansas rice producers provide check-off funds administered by the Arkansas Rice Research and Promotion Board to help support a dynamic rice breeding program by Arkansas scientists in cooperation with researchers in other states and the USDA. Check-off funding for the breeding program was started in 1980 and has increased substantially over the years. Twenty-four varieties have been released from the Arkansas breeding program since 1980. Each variety comes with management recommendations developed through research on plant nutrients, diseases, insect pests, weeds and other areas. These recommendations help farmers tailor practices to the genetic potential of each variety. Genetic improvement in disease resistance, plant types, grain and milling yields, quality and other traits have helped increase yield and grain quality while controlling production costs.

#### Impact

Thirty-three percent of the rice grown in Arkansas in 2009 was comprised of varieties developed in the Arkansas rice variety improvement program. When the program was started in 1980, the average rough rice yield in Arkansas was only 4,110 lbs/acre compared to 6750 lbs/acre in 2009. Assigning a conservative value of 60% of this 2640 lbs/acre yield increase to new varieties, the average monetary gain in 2009 over 1980, at a rough rice price of \$13.50/cwt, would be \$214/acre or \$312 million for the 1.458 million acres grown in Arkansas, of which \$103 million is due to the Arkansas varieties.

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#### Funding

Arkansas Rice Research and Promotion Board; University of Arkansas Division of Agriculture

### Asian soybean rust monitoring program prevents major crop losses

#### Issue

In November 2004, Asian soybean rust spores were moved into the United States from South America by Hurricane Ivan. The disease was detected on late-maturing soybean plants in 9 states, including Arkansas, but was winter-killed to central Florida. In 2005 and 2006, a major drought kept the disease from expanding northward until late October in 2006. A mild winter and wet spring in 2007 allowed the disease to develop and spread into Arkansas ninety days early than the previous year. Although an extremely dry August slowed the progress of the disease, several thousand acres were impacted by soybean rust. This was the first year that growers actually observed damage in the field as a result of soybean rust. In 2008, soybean rust was not confirmed in soybean sentinel plots and grower fields in southeast Arkansas until September. Although Asian soybean rust has not caused widespread yield loss in Arkansas, the disease has spread throughout the Gulf Coast over the last few years, increasing its overwintering area and potential damage to Arkansas producers in the future. With early detection and warning, Arkansas growers can respond appropriately with fungicides, and hopefully protect our yield potential as well as slow the northward progression of the disease into the Mid-West. Yield loss estimates for the southern U.S. from an uncontrolled soybean rust epidemic remain in the 50% range.

### Action

The soybean rust working group worked with national, state, and local groups to monitor the movement and development of soybean rust from the Gulf States into the central United States including Arkansas. In Arkansas, the monitoring program consisted of 25 soybean sentinel plots and multiple Kudzu plots that were samples every week for the presence of soybean rust. All data and information gathered each week is disseminated through state and national information networks to producers in Arkansas and surrounding states. Dissemination of accurate and timely information has remained the key component in managing an outbreak of soybean rust.

#### Impact

Soybean Rust entered the state in early August in Chicot County. Environmental conditions in August limited the spread of soybean rust to other soybean producing counties. It was not until early September when soybean rust spread throughout eastern Arkansas and eventually to every county in Arkansas except for two. In early September, approximately 1.1 million acres of soybeans were still at risk for yield loss due to soybean rust. Fortunately, the monitoring program aided in providing the timely information needed for growers to make effective management decisions. It is estimated that Arkansas producers saved an estimated \$9,000,000 as a result of the soybean rust monitoring program (~500,000 acres of 1.1 million at \$18.00 per acre).

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#### Funding

Arkansas Soybean Promotion Board and North Central Soybean Research Program; University of Arkansas Division of Agriculture

### Precision agriculture technologies can increase environmental stewardship of nematicides in cotton

#### Issue

Nematicides are the most widely used nematode control measure in Arkansas and other cotton producing states. Without the use of nematicides, growers could easily see a 15 to 25% reduction in yield in some fields. The two most commonly used nematicides for controlling *M. incognita* in cotton are aldicarb (Temik), a non-fumigant nematicide, and 1, 3 dichloropropene (Telone II), a soil fumigant. Common drawbacks to routine use of nematicides include cost of materials and the human hazards associated with their application.

#### Action

Evaluations of select precision agriculture technologies were conducted to provide information for increasing the awareness of yield loss resulting from nematode damage and effectiveness of current strategies using nematicides in cotton. Three farms were chosen to represent the cotton producing areas in Arkansas with historic yield loss from nematodes. Soil electrical conductivity (SEC) zones were generated using a Veris 3100 mobile electrical conductivity cart coupled with a global positioning system in at least one field on each farm. Nematode distributions were determined for the SEC zones, and prescription nematicide application maps were constructed utilizing current damage thresholds for Arkansas.

#### Impact

Results of this 4 year study (2006-2010) showed that accurate sampling techniques were vital to understanding the severity of nematode problems in a select field. Utilization of SEC zones to provide a more accurate sampling method showed nematode distributions to be extremely non-uniform, and provided a good opportunity for site-specific application of nematicides (placement of pesticide only where needed). The two year study indicated that a producer could reduce his nematicide inputs by an average of 30% without limiting his yield potential. A 30% reduction in nematicide inputs resulted in a savings of estimated \$11.00 per acre for the chemical alone, without considering the savings in fuel and equipment use for the application. Statewide, growers treat about 200,000 acres annually for nematodes; therefore, a potential 30% reduction over 200,000 acres would be about 2.2 million dollars in direct savings to producers if precision agriculture technologies were adopted.

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#### Funding

Arkansas Cotton Promotion Board; University of Arkansas Division of Agriculture

### A soil-based nitrogen test for Arkansas rice production, N-ST\*R

#### Issue

Direct-seeded, delayed flood rice (Oryza sativa L.) represents an important commodity for many Mid-south states in the U.S. and is at times grown continuously, but more often grown in rotation with soybean [Glycine max (L.) Merr.] or other crops. Arkansas is the primary rice producing state in the U.S. and harvests roughly 1.3 million acres per year. Current N fertilizer recommendations for rice in Arkansas are based on cultivar, previous crop, and soil texture, which does not account for potentially mineralizable soil-N. Recommendations made using the current system do not take into account the amount of N that is being supplied by the soil and thus, can result in over or under application of N fertilizer. This in turn could cause economic losses due to reduced grain yields, increased disease susceptibility and lodging. Identification of a soil-based nitrogen test for rice production will allow more precise application of nitrogen fertilizers while utilizing native soil nitrogen and lowering potential environmental impacts due to excessive nitrogen application.

#### Action

A six year study involving laboratory and field trials has developed an alkali direct steam distillation technique for determining the nitrogen mineralization potential of a soil. Results collected from 25 site-years on silt loam soils shows a strong correlation ( $r^2 = 0.89$ ) between the nitrogen fertilizer required to achieve 95% relative grain yield for rice and the nitrogen liberated with the new soil test when the soil was sampled to the 18-inch depth. The new soil nitrogen test is named 'Nitrogen-Soil Test for Rice' or 'N-ST\*R'. N-ST\*R was validated at eight silt loam sites in 2009 that varied in native soil nitrogen availability. N-St\*R predicted the correct nitrogen fertilizer rate to achieve 90%, 95% and 100% relative grain yield at all eight sites. Validation studies will continue in 2010 on silt loam soils; and if N-ST\*R proves accurate again, the new test will be evaluated in 2011 in the Rice Research Verification Program. The states of Louisiana, Mississippi, and Texas have started collaborating with us on the development of N-ST\*R. The success of N-ST\*R on silt loam soils in Arkansas has led to research with clay soils in the hope that we can have a nitrogen test for all of the soils were rice is grown in Arkansas and the southern Ricebelt.

#### Impact

The new Nitrogen-Soil Test for Rice or N-ST\*R will enable more accurate nitrogen fertilizer rate recommendations for rice because it will allow the producer to make nitrogen fertilizer decisions on an individual field basis rather than relying on a regional soil type basis. Implementation of N-ST\*R will enable the optimal use of nitrogen fertilizer leading to the most optimum agronomic and economical rice yield with minimal disease and lodging while lowering the potential impact of the nitrogen fertilizer to the surrounding environment.

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Arkansas Rice Research and Promotion Board; USA Rice Foundation; University of Arkansas Division of Agriculture

# Selecting and maintaining zoysiagrasses in Arkansas

#### Issue

Zoysiagrass is a turfgrass species which has been slowly increasing in use across the United States since it was first introduced around 1900s and first grown in Arkansas in the 1950s. Zoysiagrass was immediately popular in the Southern U.S. in because few well-adapted species for lawns were available and because zoysiagrass could be maintained with less nitrogen fertilizer than bermudagrass. Current research in Arkansas is examining which zoysiagrass cultivars are best adapted as well as recovery and resistance to divoting and traffic injury in addition to other work examining the best fertilization practices for zoysiagrass golf course fairways and home lawns.

Despite the large body of scientific literature on zoysiagrass, much of this information remains largely unavailable to turfgrass practitioners including golf course superintendents and sod producers. Often, cultivar selection is based solely on local availability of sod and many well-adapted cultivars are not planted in certain environments because of limited availability or lack of information describing the differences between cultivars.

#### Action

A review article was written and published in Applied Turfgrass Science to provide a thorough overview of the procedures for selecting zoysiagrass cultivars. Much of the information from this review article is available in three extension publications on 1) Choosing a grass for Arkansas lawns (FSA2112), 2) Growing turfgrass in shade (FSA6140), and 3) Zoysiagrass lawn calendar (FSA6122). Another publication (Arkansas sod source directory, FSA6138) highlights which turfgrass producers in Arkansas sell various zoysiagrass cultivars.

#### Impact

A review article, extension publications, and popular press articles are now available to aid in the selection of zoysiagrass cultivars by turfgrass practitioners, turf producers, and homeowners. These tools are intended to help residents of Arkansas make informed decisions when selecting turfgrass varieties. Planting well-adapted cultivars will improve turfgrass quality, and reduce reestablishment costs from winterkill or drought and ultimately increase sustainability.

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#### Funding

Golf Course Superintendents Association of America; National Turfgrass Evaluation Program; United States Golf Association; University of Arkansas Division of Agriculture

# Turf basics: providing outreach to a high turnover industry

#### Issue

It is estimated by some that employee turnover in the turfgrass and green industry is near 50% every five-years. Therefore, it is important that extension education programs be directed at clientele new to the turfgrass industry.

#### Action

In addition to multi-day turfgrass short courses already offered by the University of Arkansas Division of Agriculture Cooperative Extension Service, a one-day turfgrass seminar was created in 2007 called the "Turf Basics Seminar". The program offered in multiple, alternating locations each December in Arkansas was designed for beginners in the turfgrass industry or for more experienced professionals who want a review on the basic fundamentals of turfgrass management. This seminar covers the basics on plant growth, turfgrass identification, turfgrass establishment and cultural practices such as fertilization and mowing, as well as pesticide safety.

#### Impact

Education was provided to over 150 clientele in Arkansas with this program during its first three years. Ninety-five percent of attendees indicated that they would attend similar seminars or recommend others attend. Ninety-seven percent of attendees indicated that they feel better equipped to do their job after attending the seminar. Ninety-six percent of attendees indicated that this seminar helped them to increase their knowledge of pesticides, nutrients, and water inputs needed for maintaining turfgrass. Ninety-four percent of attendees indicated that would manage turf in a more environmentally conscious manner after listening to discussion at the seminar. Seventy-eight percent of survey respondents indicated that attending this seminar would help their company save money. Overall, this feedback from attendees indicates the success of this one-day training module.

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#### Funding

University of Arkansas Division of Agriculture

## Using interactive budgets for production and financial management: A case study for berry production in Arkansas

#### Issue

Production of raspberries and blackberries in Arkansas is growing as more consumers demand a local supply of fresh, high quality fruit. Demand for these fresh berries still typically exceeds supply in much of the state particularly early and late in the production season. Commercial production with high tunnels offers promise for those producers willing to make the necessary capital investment for early and/or late season production. Consequently, estimating the costs of production and conducting what-if analyses around costs, revenues and production levels are important components for planning and for financial management of fruit production.

#### Action

Interactive blackberry and raspberry production budgets (that allow with and without/high tunnel production for extended seasons) were developed in excel. Sample costs for labor, materials, equipments and custom services are based on current figures gathered at the University of Arkansas experimental farm. Once producers select interest rate, inflation rate, planting density, expected prices, marketing plan and production practices, the budget is calculated automatically. Graphics options provide visual explanations of costs, revenues and net returns under different scenarios chosen by the user. Users can review information for any given production year or for the expected life of the orchard.

#### Impact

High tunnels show potential in Arkansas to extend the production season for raspberries and blackberries. Extended season could assist growers in capturing a larger market share, especially early and late season when premium prices are paid. Consequently, producers could use these interactive budgets to estimate operating costs, fixed costs, total costs and expected total returns by modifying an important production practice, cost or return value. Allowing comparisons among different cultivar varieties and high tunnel dimensions would assist berry producers to make better planning and financial decisions.

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#### Funding

USDA SARE; University of Arkansas Division of Agriculture

# How biomass crops can mitigate declining irrigation resources in the Delta

#### Issue

Current ground water withdrawal from the Alluvial Aquifer in Arkansas is considered to be unsustainable in the sense that water use exceeds recharge. Recent data suggest that sustainable pumping rates have decreased significantly in the Arkansas Delta. To reach sustainable pumping levels, the United States Geological Survey's 2006 estimates indicated that certain Arkansas Delta counties will need to reduce irrigation pumping rates by as much as 67%. This is significant since approximately 63% of the state's total water supply is sourced from groundwater, and further, 95% of that comes from the Alluvial Aquifer in the Delta region of Arkansas. With water supplies declining in parts of the Alluvial Aquifer, waterintensive agricultural production and associated processing industries are at risk. At the same time, interest in growing bioenergy crops, either perennial switchgrass or forage sorghum, both drought tolerant cops, is increasing and hence a shift in crop patterns may result. The thrust of this study is to estimate how the adoption of these less water intensive crops would alter land use if pumping rates from the aquifer would be restricted to semi and sustainable levels.

#### Action

A model was developed to examine how profit maximizing cropping decisions would change at a county level if producers were constrained to irrigation levels that would sustain the Alluvial Aquifer indefinitely. While there are several approaches to ensuring a sustainable water source the current method looked at capping each counties water usage under two scenarios (1) full sustainability of the aquifer and (2) doubling the life of the aquifer with and without the addition of less waterintensive bioenergy crops at various price levels.

#### Impact

Results from the model present policy makers estimates of the impacts of either taxing or "capping" water use in the Arkansas Delta on cropping allocations and on overall profitability. These estimates are particularly important since recent concerns over the decreasing water level in the Alluvial Aquifer in Arkansas has led many to question the future acreage of the water-intensive rice industry in the Arkansas Delta. The introduction of biomass crops at prices between \$50 and \$55 per dry ton was able to avert state losses to agriculture but Delta counties were still negatively impacted. In other words, agricultural income redistribution across counties is inevitable if ground water use declines continue. Percentage-wise, the introduction of the biomass crop along with irrigation restrictions affected rice less than other less profitable irrigated crops

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of cotton, soybean, corn, and grain sorghum. In essence, water savings generated by the alternative dryland crops moderated the drastic decline in rice acreage required in some counties to make water use sustainable without the option to switch to switchgrass or dryland forage sorghum. The results suggest that farmers need to look to non-groundwater based sources of irrigation water by either using irrigation water more efficiently and/or utilizing man made irrigation storage alternatives. Further research is needed to arrive at more concrete answers, especially in light of the uncertain market potential for bioenergy crops to date and perhaps for several more years.

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#### Funding

University of Arkansas Division of Agriculture, DOE Bioenergy Project

# Tetraploid perennial ryegrass – a new overseeding grass species that offers reduced chemical inputs

### Issue

Bermudagrass is often over-seeded with a cool-season turfgrass to provide full-year playing conditions. One of the most important decisions in an overseeding program is the selection of an appropriate cool-season species for a specific application. Tetraploid perennial ryegrass has been previously used in forage systems but has not been applied to turfgrass systems. It was hypothesized that this species would have better transition characteristics compared to diploid perennial ryegrass, which could lead to reduced pesticide use and reduced cost for golf course and athletic field managers. Trials were conducted to determine the optimal cultural practices for tetraploid perennial ryegrass in an overseeding environment.

#### Action

The objectives of this project were to: 1) determine the optimal cultural practices for tetraploid perennial ryegrass in an overseeding environment 2) determine cultural and chemical practices that can be employed during the transition period and 3) examine the effects of low-quality water on this species. Field and laboratory studies have been conducted to address issues such as optimal seeding rates, mowing heights, and fertilization programs and relate those practices to the grasses response to simulated traffic. In addition, field studies were employed to examine the tolerance of this grass to commonlyused herbicides. Finally, laboratory studies were used to determine the tolerance of tetraploid perennial ryegrass to low-quality, saline water.

#### Impact

This research will have a primary benefit to golf course and athletic field managers, especially in cases where transition from an overseeded grass back to bermudagrass is difficult. These studies provide a basic management program for those turfgrass managers that wish to incorporate these grasses into their overseeding program. This research has further demonstrated that tetraploid perennial ryegrass does not require herbicides to remove the overseeding grass, even in northern locations such as found in Arkansas. This reduction in herbicide use can save turfgrass managers over \$100 / acre in chemical costs each season.

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#### Funding

University of Arkansas Division of Agriculture Pennington Seed Co. NexGen Research

# Reproduction of reniform nematode on soybean varieties

#### Issue

Infestations of the reniform nematode, *Rotylenchulus reniformis*, cause significant losses in contemporary soybean varieties in Arkansas. Information on reproduction of the reniform nematode on soybean varieties and breeding lines is critical to resistance research. The objectives of this study were to provide reproduction data of the reniform nematode infecting contemporary soybean cultivars to the Arkansas Cooperative Extension Service.

#### Action

Soybean breeding lines were identified to develop reniform nematode resistance in cooperation with southern soybean breeders from Arkansas, Missouri, North Carolina, USDA (Jackson, Tenn.), and South Carolina and nematologists from Louisiana. Late maturity lines from southern Arkansas southeastward were also screened. Extension nematologists of the southern states of Texas, Louisiana, Alabama, Mississippi, Georgia, Florida, and South Carolina continue to request reniform data on soybean cultivars to help in the selection of reniform resistant crops for rotation in reniform infested fields, especially cotton where no commercial varieties have resistance because no available resistance to the reniform nematode in upland cotton has been identified. A companion study with Missouri soybean researchers is determining genes involved with reniform nematode resistance in soybean.

#### Impact

This study is invaluable in determining molecular markers of reniform nematode resistance in soybean. Taxonomic studies help in the worldwide diagnosis of nematode disease losses by providing scientists with dependable methodology for accurate diagnostic and quarantine nematode identifications.

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#### Funding

University of Arkansas Division of Agriculture

# The early performance of an organic orchard with different ground cover and nutrient management systems

#### Issue

Organic crop production and consumer demand grew dramatically in the past decade, and consumer demand and use of organic products continues to grow. However, there is limited organic tree fruit production in Arkansas and the Southern region. Earlier survey work of growers, potential growers, consultants and extension workers, markets and food processors indicated a strong potential for organic tree fruit but that production was limited due to lack of science-based research and demonstration within the state and region. Further, there was lack of scientific and extension expertise and experience. Because of the strong interest and opportunities for organically produced fruit within the state and region, and because of the lack of science-based information and technology, a project was initiated to study methods of organic apple production.

A survey of growers indicated that key concerns for organic production would be to provide the tree with sufficient nutrition so as to maintain healthy growth and adequate cropping capacity, and developing means of minimizing competitive under-tree vegetation which might limit tree growth through competition for nutrition and water. The organic orchard project studied the interaction of organic nutrient sources and alternative means of managing the competitive undertree vegetation.

#### Action

A certified organic orchard was established in 2006 after preparing the site for organic production the previous year. The project is expected to continue for a minimum of 10 years. Trees of the multiple disease resistant cultivar Enterprise were planted at moderate density (600 trees/acre) on M26 rootstock. Treatments were begun at planting as follows: Nutrient Sources, 1) a control where nutrition is provided by the ground cover management system, 2) using locally available composted poultry manure, and 3) using a certified pelletized poultry-based organic fertilizer; Competitive Vegetation Management systems tested were, 1) urban green compost, 2) wood chips collected from a local utility, 3) shredded white paper collected from a local institution, and 4) a 'mow-andblow" where the planted vegetation of tall fescue and white clover are grown under the tree and frequently mowed and the vegetation from between rows is blown under the trees as a mulch. Trees were grown for two years. Some treatments grew significantly to the point where they could crop in year 3 and all trees were cropped in year 4. During this period the growth and early productive potential of the trees is indicative of the ultimate performance of the system.

#### Impact

This study, to date, has indicated that apples can be grown organically in Arkansas and there is significant production potential. The study demonstrates that adequate nutrition can be provided by either added nutrient sources such as composted poultry litter or commercial fertilizers, and that a lack of nutrition, although providing for tree acceptable tree growth may limit production in the organic system. The undertree vegetation management system has profound effects on tree growth and early production capacity.

This study, although early in its life, has already provided results that inform growers, consultants and extension workers on the means of establishing and maintaining an organic orchard. Workshops for growers and extension workers have been held to extend the information and technology generated by this study to those audiences. The orchard has provided living demonstration and classroom opportunities for elementary school students, high school students, university students, and local and multi-state extension consultant tours as well as a teaching facility for orchard operation management and pruning for growers. Results of the project have been given at local, state, regional, national and international grower and scientific conferences.

As a result of the study, growers who chose to produce organically are better informed. Likewise, the collaborators on this project have better knowledge, expertise and experience by which they can assist growers. AS growers adopt these technologies, it is expected that there will be more locally-grown organic fruit to satisfy local consumer markets.

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#### Funding

Southern Region Sustainable Agriculture Research and Education Program; USDA – National Organic Program; University of Arkansas Division of Agriculture

# Off-season organic blackberry and raspberry production can increase farm sustainability

#### Issue

Organic berry production in Arkansas and the southern region has been limited by several factors. First, there is very little science-based technology demonstrating the means of organic berry production in the state and region. Second, some berries, such as raspberries, have limited production in the state and region due to high summer temperatures which negatively affect fruiting. Third, although blackberries and raspberries are perennial plants and require year-around care, their production and harvest season is very limited. These factors limit production opportunities for producers and product availability for consumers.

However, the technology of high tunnels, minimally structured and equipped arched greenhouse-like structures, may provide an opportunity to modify the environment allowing the production of berries not normally able to be grown, and grow them outside the traditional production and marketing season. Conceivably, with the combination of high tunnels and genotype selection, the normal harvest season of 6 weeks could be extended to 3 or more months. High tunnels, as a means of excluding rain and pests, could facilitate the production of organic fruit of high value further.

This project was developed to investigate the production issues for a new crop, organic primocane blackberries and the economics of extending the season of blackberries and raspberries, for increased income by using high tunnels. This project was developed in response to grower, stake-holder groups that encourage us to develop production systems for organic fruit production, and to develop additional crops outof-season, particularly for spring and fall markets where there is a paucity of traditional season fruit available for market.

#### Action

A three year, interdisciplinary project was begun with the following goals: 1) to determine organic management practices for out-of-season blueberry, raspberries and blackberry production in high tunnels, 2) performed an economic analysis of each crop; and 3) to develop interactive enterprise budgets so that growers may examine the profitability of long term production. The project was conducted in Arkansas and Georgia with blackberries and raspberries being studied in Arkansas and blueberries being studied in Georgia. Tunnels were constructed and plants planted in April 2006 and allowed to fruit in the three subsequent cropping season. Three studies for blackberries and raspberries were initiated being, 1) advancing the production of summer fruiting genotypes into the spring, 2) delaying and extending the autumn production of new Arkansas-developed primocane fall-bearing blackberry genotypes and public primocane raspberries, and 3) double cropping berries with advanced spring production and delayed fall production in the crops. The season extension and environmental production was provided by high tunnels and these were compared to similar traditional field planted berries.

#### Impact

This project clearly demonstrated a strong potential for using high tunnels as a part of a farm operation strategy. Tunnels advance the summer season and extended the fall season significantly providing fresh fruit for consumers at times when it is not generally available. Total yield, marketable yields and fruit size were generally larger in tunnels than corresponding field plots and less fruit were lost due to frost, rain damage or disease. Additionally, tests were conducted on grower-cooperator farms as a means of validating replicated studies and in order to provide farm-scale demonstrations for other growers. Workshops and presentations at state, regional and national meetings presented these results to growers, consultants and extension agents and to classroom students both of college and high school. Through workshops and farm tours, Growers in Ark., Okla., Mo., and Ga. learned the potential of bramble production methods in high tunnels to expand the production and marketing season with advanced spring production and extended autumn production.

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#### Funding

USDA Organic Research Extension Initiative; Organic Farming Research Foundation; North American Bramble Growers Association; Southeastern Small Fruit Consortium; University of Arkansas Division of Agriculture

# Importance and management of seedling diseases caused by *Pythium* spp. on rice

#### Issue

Stand problems consistently cause production losses in Arkansas rice fields. The causes of stand problems are often difficult to determine; thus practices that would eliminate or reduce the amount of losses are not able to be implemented. Poor stand establishment is commonly associated with cool soil temperatures (early planting) and saturated soils. Stand problems also have been associated with other environmental and soil factors, herbicides, insects, and seedling diseases. The role of soilborne pathogens, especially Pythium spp., in stand losses and reduced early-season development in rice have been documented. The use of more cold-tolerant cultivars that are better adapted to marginal environmental conditions may be effective in reducing losses and rice genotypes with cold tolerance and *Pythium* resistance in the rice breeding program hold the promise for more reliable stand establishment for rice under marginal planting environments.

#### Action

The role of seedling disease pathogens in stand establishment problems on rice were examined in field and controlled environmental studies using selective fungicides and pathogen isolation from seedlings. *Pythium* spp. were the most common group of seedling disease pathogens isolated from rice seedlings. The *Pythium* spp. recovered from over 20 producers' fields from these studies in Arkansas were identified and characterized for pathogenicity (stand loss) and selected isolates were identified morphologically and molecularly using the mitochondrially encoded cytochrome oxidase II gene (mtDNA cox II). The effect of other soil factors, soil electrical conductivity (salinity), on rice stand establishment and the development of rice seedling diseases caused by *Pythium* spp. was examined using soil from a field near Lake Hogue in Poinsett County. In the presence of *P. torulosum*, stands were reduced at salinities as low as the 1144  $\mu$ S/cm salinity treatment, with differences between infested and non-infested pots being most apparent in the 2022  $\mu$ S/cm salinity treatment. This study suggests that in fields having moderate salinity problems, damage from *Pythium* species will be more severe.

#### Impact

These studies demonstrated that Pythium spp. are a major part of the seedling disease complex on rice. The research identified the important species of Pythium in rice producers' fields in Arkansas. By identifying the most important seedling pathogens and other factors limiting stand establishment, strategies for managing seedling diseases, including the development of cultivars with disease resistance to Pythium spp. and the use of fungicide seed treatments, will help to develop earlier rice production systems by ensuring reliable stand establishment under marginal environmental conditions. The research also suggests that salinity may be a greater factor affecting stands as a result of its interaction with seedling disease pathogens commonly found in soil. The knowledge of salinity and its effects on the virulence of different pathogens could be a useful tool to assist producers in selecting appropriate management practices.

#### Contacts

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#### Funding

Rice Research and Promotion Board; University of Arkansas Division of Agriculture

# Seed treatments to improve soybean stand establishment and yield even with low quality seed

#### Issue

Soybean yield starts at planting and depends on the quality of the seed planted. To get a strong, healthy stand under the planting environments faced by Arkansas growers, high quality, vigorous soybean seed is essential. Stands and yields are further reduced by seedling diseases which have even more impact when low vigor seed are planted under stressful environmental conditions. Unfortunately, growers rarely know the vigor of the seed they are planting. To fight seedling diseases and improve stands, growers use a variety of seed treatments, but these treatments vary in effectiveness depending on the type of soil, the planting date, and the pathogens that are attacking the seed and seedlings. Knowing which seed treatment to use and when to use it will improve yields and save growers money.

#### Action

The most commonly available seed treatments, some with activity against specific pathogens and some with a broad spectrum of activity, were compared at three locations in Arkansas (Keiser, Stuttgart, and Rohwer) at three planting dates (April, May and June). In another test, seed lots representing different levels of vigor were planted at different densities, with and without seed treatment. Stands were counted and yields taken. In addition, soybean seeds were planted in soil from Stuttgart and Hope in growth chambers to compare stands and pathogens isolated from rotted seed and from seedling roots. **Impact** 

Metlaxyl (specific for *Pythium* spp) and broad spectrum seed treatments resulted in the highest stands and yields at most locations and planting dates, although these improvements were not observed in every test. Improvements in stand and yield occurred most often in the April and June plantings when the seeds were stressed by either cold or heat, but were also seen in the May plantings. Fungicide seed treatment improved stands and yields with seed of all qualities, but the impact was greatest with poor quality seed, especially when planted at a low seeding rate. Isolations from rotted seeds and from seedlings in the growth chamber tests showed that *Pythium sylvaticum* was the most common pathogen recovered from rotted seed and *Fusarium oyxsporum* the most common isolated from seedling roots. Metalxyl was the most effective fungicide in the growth chamber experiments with both soils.

Our results show the importance of seedling diseases and seed quality to soybean production in Arkansas. We are also establishing effective and economical control measures that ensure proper stand establishment across a variety Arkansas of planting conditions. Our isolation work is identifying the key components of the seedling disease complex. This will help us direct future research.

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#### Cooperators

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#### Funding

Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture

### Detection of charcoal rot in soybean with remote sensing

#### Issue

Charcoal rot is a soybean disease that causes significant economic losses. It often strikes the plant when the plant is already stressed due to lack of water and nutrients, or during reproduction. Hence it is difficult to detect. Some of the cultivars of soybean have shown some resistance to this disease. If the onset of disease can be detected with remote sensing in multiple cultivars with different degree of resistance, that would save a lot of time and effort on the part of the grower.

#### Action

The part of this multistate project focused on here is to identify whether remote sensing is an effective tool to monitor the disease, especially early during the infestation. We have conducted two years of microplot experiments with four different cultivars (with different degree of resistance), two levels of disease treatment, and two levels of water stress. The plants were monitored for canopy reflectance, stomatal conductance, canopy temperature, disease rating, and other factors. Unfortunately, the excessively wet 2008 season was not favorable for active disease proliferation. We are still analyzing the data from 2009.

#### Impact

If the disease can be detected with remote sensing, it will be a powerful tool to map and identify diseases in large scale. This will allow the farmers and crop consultants to understand the yield impact (damage) caused by this disease, and to establish remedial measures in a site-specific fashion.

#### Contacts

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#### Funding

United Soybean Board; University of Arkansas Division of Agriculture

# A transgenic approach to reduce aflatoxins in corn

#### Issue

Aflatoxin is the most important grain quality problem of corn in Arkansas and the South. In 1998, an aflatoxin outbreak cost Arkansas growers an estimated \$15,000,000 and made a significant portion of the crop unmarketable. Since then, growers have focused on intensive irrigation and other crop management methods to minimize the problem, but each year we continue to have localized outbreaks that reduce profits and create marketing problems by increasing fear and wariness among grain buyers in the region. A real solution to aflatoxin and other mycotoxins in corn would be worth millions each year to our growers, and could have a major impact on other crops affected by these problems.

#### Action

Previous work has demonstrated that the  $\alpha$ -amylase inhibitors (AI) of hyacinth bean inhibited the breakdown of starch necessary for both fungal growth and the subsequent accumulation of aflatoxins. The objectives of this study were to express an  $\alpha$ -amylase inhibitor from this legume in corn, which is expected to result in a significant reduction in both fungal infection by *A. flavus* and aflatoxin accumulation in kernels. AI's inhibit the  $\alpha$ -amylase activity of *A. flavus* and fungal growth as well, but don't inhibit the maize, porcine, or human  $\alpha$ -amylases. AI gene family member B01 has been cloned into the plant transformation vector 1300S, which is designed to express B01 in all tissues. Twenty-one lines with the B01 AI transgene have been regenerated and are being grown to maturity in the greenhouse. Seed from each of these lines will be tested for their ability to inhibit *Aspergillus flavus* infection and aflatoxin accumulation compared to the wild type control.

#### Impact

These transgenic lines represent the first attempt to develop *A. flavus* and aflatoxin resistance through a transgenic approach in the U.S. The benefit of a transgenic approach over conventional breeding is that this  $\alpha$ -amylase inhibiting transgene has been shown to be approximately 37 times more effective at inhibiting than the most effective native gene, a trypsin inhibitor, in corn. The potential of a transgenic approach to reduce aflatoxin accumulation in corn is much greater than what can be achieved through conventional breeding. The expression of the transgene will vary among transgenic lines so all regenerated lines will be tested for expression levels.

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Arkansas Corn and Sorghum Promotion Board; University of Arkansas Division of Agriculture

### Molecular diagnostics for nematodes pathogenic on soybeans

#### Issue

Due to changes in the soybean seed industry, growers are required to make variety selections earlier than ever before, so that they may obtain seed before inventories are depleted. In order to make appropriate seed selections, producers need to know whether pathogenic nematodes are present in their soils. To obtain this information, growers send soil samples to the nematode diagnostic clinic at the Southwest Research and Extension Center at Hope, Ark. Every fall this clinic receives thousands of soil samples for processing. Currently, the Cooperative Extension Service relies on a slow and time-consuming microscopic process for nematode identification and counting. **Action** 

All current polymerase chain reaction (PCR) based methods for two of the three most important nematode species including root-knot (RKN) and soybean cyst (SCN) have been tested. PCR primers specific for reniform, have been designed. Numerous races of soybean cyst nematode have been obtained courtesy of Bob Rigs. In addition, several reniform and rootknot nematode have been collected courtesy of Bob Robbins and Terry Kirkpatrick, respectively. The internal transcribed spacer region (ITS) of the SCN races and RKN isolates have been cloned and sequenced. ITS sequence information will be used to develop a multiplex assay for detection of all three important nematodes in a single assay. DNA extraction methods for the nematodes are being optimized for both individual and bulk nematode samples.

#### Faculty Impact Statements 2009

#### Impact

By improving the speed at which the nematode diagnostic clinic is able to process soil samples, the clinic will be able to provide more timely information to growers concerning nematode infestation. Growers will then be able to make informed decisions on seed purchase such as whether to plant a resistant variety or a higher yielding susceptible variety. A molecular diagnostic method will also reduce the labor in processing thousands of samples by eliminating the approximate 40% of samples that do not have any significant numbers of nematodes in them.

#### Contact

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Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture

### Glyphosate-resistant pigweed development in cotton and soybean

#### Issue

An estimated 350,000 acres of cotton and soybeans were infested with glyphosate-resistant Palmer amaranth (pigweed) in Arkanasas in 2009. This problem cost growers over 17 million dollars in the form of added weed control costs and lost yields.

#### Action

Recommendations for control of glyphosate-resistant Palmer amaranth (pigweed) in both Roundup Ready and Liberty Link Cotton and Soybean were developed for 2010.

#### Impact

Research conducted in 2008 and 2009 has led to the development of strategies for the control of this pest using existing technology and new technology (Ignite in LL soybean). In 2010, approximately 50% of cotton and soybean growers will adopt at least one of these resistance management strategies as a result of this program. A fact sheet, several popular press articles, TV spots, grower meetings and field days were used to get this information out. Recommendations in the State Weed and Brush Control Guide (MP44) have been updated.

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# Nighttime air temperature during kernel development can affect rice milling quality

#### Issue

Rice milling quality, specifically head rice yield (HRY), can inexplicably vary from one lot to another and from year to year. Head rice yield is the mass fraction of rough rice that remains as head rice after milling; head rice represents milled kernels that are at least three-fourths the original kernel length. Our previous research has shown that HRY can decrease at high harvest moisture contents (MCs) due to the presence of weak, immature kernels. At low harvest MCs, HRYs can plummet due to fissures created by rapid moisture adsorption by low-MC kernels; most fissured kernels will break during milling, thereby reducing HRY. Peak HRYs, attained at approximately 19% to 21% MC for long-grain cultivars, can vary from levels of approximately 60% to 70%. One cause could be the temperatures experienced during the nighttime hours of kernel development.

#### Action

In collaboration with RiceTec, Inc. in Alvin, Texas, a controlled-temperature study was conducted using large growth chambers, testing nighttime temperatures of 18, 22, 26 and 30 °C throughout kernel development, using rice cultivars Cypress, LaGrue, XP710, XL8, M204, and Bengal. As nighttime temperature increased, HRYs significantly decreased for all cultivars except Cypress and Bengal, for which HRYs did not vary.

A field study was subsequently conducted to test nighttime air temperature effects during various reproductive stages on peak HRYs of cultivars Bengal, Jupiter, Cypress, LaGrue, Wells, and XL723 grown in 2007 and 2008. The rice was grown at locations from southern to northern Arkansas with anticipation of variations in nighttime temperatures during kernel development. Cultivars from each plot were harvested over a range of MCs in order to determine peak HRYs. Frequency distributions of nighttime air temperatures during reproductive stages were plotted for each cultivar grown at each test location. For each frequency distribution, the temperature at which 99% of temperatures were less (the 99% quantile) was determined for each reproductive stage. The 99% quantiles of nighttime air temperature frequency distributions during the R6 (kernel filling) and most R7 reproductive stages were significantly and inversely correlated with peak HRY. For all cultivars grown in both seasons, the 99% quantiles of nighttime air temperature distributions and HRY had correlations of -0.472 during R6 and -0.399 during the R7 reproductive stages. Nighttime air temperatures during the R8 and R9 reproductive stages showed no correlation with HRY.

#### Impact

This research has shown, at both the lab and field levels, that peak HRY is inversely affected by nighttime air temperatures during the kernel filling stages of reproductive growth. The research has also shown that the effects of nighttime air temperatures are cultivar dependent. This finding provides promise that genetic improvements can be sought to reduce the impact of high nighttime air temperatures.

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#### Funding

University of Arkansas Division of Agriculture Corporate sponsors of the U of A Rice Processing Program Arkansas Rice Research and Promotion Board

# Presence of unneeded DNA elements in transgene locus

#### Issue

An ideal transgenic plant is expected to contain a precise transgene locus and nothing else. However, for the identification and recovery of transgenic plants, it is necessary to cointroduce selection marker genes.

#### Action

Precise transgene locus can be efficiently developed by recombinase-mediated gene transfer technique, which utilizes Cre-lox recombination system. To remove selectable markers from precise integration locus, a second recombination system, FLP-*FRT*, can be employed. However, efficiency of FLP-*FRT*, is generally low. To develop an efficient FLP-FRT system for rice, modified FLP genes called FLPe or FLPo are applied. Additionally, the basis of weak FLP-FRT activity was determined.

#### Impact

This project will lead to the development of an improved recombination system that can be used for genetic manipulation of crops, and implementation of a streamlined method for generating marker-free transgenic lines. In 2009, we developed an alternative approach to overcome weak recombinase activity. The alternative strategy was demonstrated to be efficient in site-specific gene integration.

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#### Funding

University of Arkansas Division of Agriculture; Arkansas Bioscience Institute; USDA/CSREES/Biotechnology Risk Assessment

### Unraveling molecular mechanisms of gene suppression for a broader understanding of plant response to environment, disease and defense

#### Issue

Genetic variability is an extremely important resource for developing new crop varieties. This resource can be further enriched by tapping into epigenetic variability. Epigenetic processes involve chromatin remodeling and play an important role in disease manifestation, defense process and development. Additionally, the epigenetic processes are conserved in plants and animals.

#### Action

Researchers performed molecular and genetic characterization of an epigenetic mutant of *Arabidopsis* phytochrome A gene.

#### Impact

Understanding of molecular mechanisms of gene suppression (or expression) may lead to the development of a technology for engineering epigenetic traits.

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### Functional genomics of rice genes

#### Issue

Several rice genes isolated by a genomics approach must be validated for function by mutating the gene and assessing the loss-of-function effect. While targeted mutagenesis technology is not available for most plants, targeted gene silencing is widely applied for functional genomics. A standard procedure relies on the assembly of an inverted-repeat construct to carry out targeted gene silencing. This construct is a bit cumbersome to assemble, especially when working with multiple genes.

#### Action

We identified a simple template for robust gene silencing in plants using *Arabidopsis* as the model and are currently working on testing the efficiency and efficacy of this template in rice cells.

#### Impact

The simpler template will serve as a genomics and biotechnology tool.

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# Economic analysis of soybean production practices

#### Issue

Arkansas soybean producers in 2009 began the year with weather-related planting delays and replants before a record wettest rainfall year delayed harvest and damaged soybean quality. These challenges added to the normal adjustments to new disease/insect pressures and new production inputs/technology required that producers develop a greater understanding of their exposure to risk in both the domestic and global economies.

#### Action

The three-objective approach taken to address these issues was to: (1) conduct an economic analysis of production practices used in the Arkansas Soybean Research Verification Program that impact profitability and verify Extension recommendations; (2) standardize the economic analysis by integrating current year verification program data with data from previous years to document the long-term benefits of the Soybean Research Verification Program (SRVP); and (3) provide economic assistance for other research projects, specifically the "Improving Technology Transfer for Profitable and Sustainable Soybean Production" project of the UA Cooperative Extension Service (CES). The 2010 CES cost of production budgets were changed by placing the generation under one economist for all crops and implementing an interactive system with input from each respective crop economist. An economic budget analysis was developed for each SRVP producer and the complete program results were compiled by system. Daily quotes from Arkansas soybean markets were recorded with analysis and summaries distributed electronically across the CES network in the weekly "Soybean Notes" or "AR Soybean Market Review" newsletters. More specific information was provided through county and regional soybean meeting presentations by the CES. Soybean economic information generated by this effort was distributed beyond Arkansas by poster presentations at multi-state soybean forums.

#### Impact

Soybean production in Arkansas occurred on an estimated 3.4 million acres in 2009 with total production over 122.6 million bushels. The total value of soybean production in 2008 exceeded \$1.09 billion. The Soybean Research Verification Program has helped producers increase bean yields from 26 bushels per acre in 1995 to a record 38 bushels in 2008. Twenty five counties produced more than 1 million bushels each in 2008. More than 5 thousand Arkansas farms were reported as growing soybeans in the 2002 Census of Agriculture. The economic analysis provided by this project continues to address new technology, such as in the 2009 LibertyLink soybean budgets. Producers receive decision making information and are shown how their choices impact the entire Arkansas soybean industry.

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#### Funding

Arkansas Soybean Promotion Board; School of Agriculture, University of Arkansas at Monticello; and University of Arkansas Division of Agriculture

# Japanese beetle biology and control in Arkansas

#### Issue

The Japanese beetle is a serious exotic pest that entered Arkansas in about 1997. The beetle is steadily spreading throughout the state and will be a permanent problem for homeowners, growers of horticultural crops or turf managers. Beetle larvae damage turf and the adults feed on hundreds of horticultural species.

#### Action

In 2009, we tested an effective new insecticide, Acelepryn<sup>®</sup>, for control of 1st, 2nd and 3rd instar Japanese beetles. We developed LC50s for this compound against all three instars. We also looked at the efficacy of capsaicin as a feeding deterrent. We have conducted comprehensive surveys of larval densities in Arkansas, which will help to determine whether to apply insecticides and, if so, when and where. We received a permit to introduce a new microsporidial biological control agent to use against Japanese beetle larvae. Finally, we developed massrearing techniques for producing large numbers larvae needed for the research with the microsporidium.

#### Impact

Our results from turfgrass research will lead to less damage from Japanese beetles, less use of insecticides, and increased economic returns to horticulturalists and golf course managers. Golf course and turf managers can use our information on resistant grass varieties to help make decisions about grasses to plant to reduce damage from Japanese beetle larvae. Our data on the effects of Acelpryn<sup>®</sup> and other chemicals on Japanese beetle larvae in turf will make it possible to make informed decisions on chemical control for this insect pest. The research on the microsporidium, if successful, will result in long-term reduction of Japanese beetles, which will benefit homeowners, turf managers and horticultural growers alike.

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#### Funding

Arkansas Department of Agriculture; University of Arkansas Division of Agriculture

# Impact of honey bee pathogens and parasites

#### Issue

The honey bee is one of the most important insects in the United States. Its value as a pollinator of many crops, including almonds, apples, melons, and berries, is estimated at \$14 billion per year. A parasite, the varroa mite, is considered the number one problem facing beekeepers worldwide and is implicated in putative Colony Collapse Disorder. Pathogens of honey bees, such as *Nosema ceranae*, have also been implicated in honey bee declines. It is essential for the nation's agricultural infrastructure and the nation's food supply that pollinators, particularly the honey bee, remain abundant.

#### Action

We have studied varroa mites for the past four years. One outcome has been the development of a new organic mixture of materials that can be applied as smoke to honey bee colonies. Preliminary results have shown this mixture to have greater effect on reducing varroa mites than other botanical materials. This product will continue to be pursued in future years to document its utility. We also have been studying the prevalence of the pathogen, *Nosema ceranae*, in honeybee colonies in Arkansas colonies over time. Our research results indicate that *Nosema ceranae* is not the cause of Colony Collapse Disorder in Arkansas.

#### Impact

Honey bees are the most important insect to the United States, through their pollination service. Understanding and mitigating the stresses on honey bees is critical to the long-term health of honey bee colonies and their benefits to agriculture. Developing better, sustainable control methods for Varroa mite will improve colony health and make the bees less susceptible to other stresses, both environmental and humaninduced. Our determination that *Nosema ceranae* is not the causative agent for Colony Collapse Disorder will help direct other research to aid in solving the riddle of this nationwide situation.

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University of Arkansas Division of Agriculture

#### Tarnished plant bugs in Arkansas

#### Issue

The tarnished plant bug, *Lygus lineolaris*, is the one of most serious pests of cotton in Arkansas and a major pest of many other crops nationwide. With the success of the Boll Weevil Eradication Program in Arkansas, the importance of *Lygus* management in cotton has become more clear. Management of *Lygus* will need to include the role of any naturally occurring species that can aid in control of the tarnished plant bug. Little is known about the microbial pathogens that affect tarnished plant bug. Because of the importance of *Lygus* to environmentally safe and economically profitable cotton production, it is crucial to understand the presence and role of natural pathogens of *Lygus*.

#### Action

During our studies of pathogens of *Lygus* plant bugs in both natural prairies and agricultural fields, we found a species of *Pandora* fungus never reported from North America. Our study also included detecting and identifying naturally occurring parasitoids of *Lygus*, and identify habitat-specific occurrence of the parasitoids and the kinds of plant cues that may influence the attraction of parasitoids to plants infested by *Lygus*.

#### Impact

Our results have added to our understanding of natural enemies of *Lygus lineolaris*, one of the major insect pests of cotton in Arkansas. Our identification of the fungus and studies of the environmental conditions that enhance the growth of the *Pandora* fungus in the field will help predict its potential for causing epozootics in the field and, thus, its potential to help control *Lygus*. Our identification and study of parasitoids of *Lygus* will help us to understand the role these species may play in regulating *Lygus* in cotton and other crops. Further, understanding what plant cues in crop and non-crop habitats influence the parasitoids will help our manipulation of the parasitoids to provide greater levels of control of tarnished plant bugs as pests.

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#### Funding

University of Arkansas Division of Agriculture

### Genetic evidence found for honey bees of a Middle Eastern lineage in the United States

#### Issue

Honey bees, *Apis mellifera*, are the principal managed pollinator of agricultural and horticultural crops in the United States. *Apis mellifera* is not native to the United States and the first record of this species in the United States was during the early to mid 17th century when European settlers brought it to the United States. There is historic evidence that honey bees from the Middle East were introduced to the United States during the late 1800s. We conducted a genetic study using a mitochondrial DNA marker to determine if descendents of these Middle Eastern bees ('O' lineage) still exist in the United States.

#### Action

We conducted a study of the genetic diversity of honey bees from primarily feral populations from the central and south central United States. Of the 469 samples from 14 states, including Arkansas, subjected to DNA sequencing we found evidence of four mitotypes from the 'O' lineage. Only one of these mitotypes has been previously observed (in Lebanon). Within the feral populations that we sampled, this lineage accounted for 5%. Of the 24 'O' lineage samples, mitotype O5 was the most common and accounted for 52% of the total observed 'O' mitotypes. Phylogenetic analysis revealed that three of the mitotypes—O2, O5, and O5d—were closely related to mitotypes from Libya, Lebanon, and Egypt. However, one mitotype (O5"b) appears to have no close relationship to any of the other mitotypes.

#### Impact

The existence of the Middle Eastern 'O' lineage in the south

central and central United States suggests that further molecular genetic studies of the honey bee population is needed to utilize and conserve the genetic variation of honey bees that exists in the United States. Furthermore, this study also suggests that feral honey bees are surviving despite the introduction of the varroa mite in the 1980s, which reduced the feral and managed honey bee populations.

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University of Arkansas Division of Agriculture

# Managing false smut to reduce yield losses in rice

#### Issue

Arkansas ranks first in the U.S. for rice production. Plant diseases are critical limiting factors in achieving and maintaining high seed quality and levels of productivity. In 1997, a new disease of rice called false smut (Ustilaginoidea virens), was found in Arkansas for the first time. It is now found in all of the rice producing counties in the state. The disease reached high levels in 2008 and 2009. Though widely known in other parts of the world, little information is available that describes disease etiology, how the pathogen survives or is dispersed from one location to another. There is little information describing how the fungus infects rice plants. Additionally, there is little known about resistance to infection by the fungus in rice cultivars although many, if not all appear to be highly susceptible. In other parts of the world, this disease has already become very serious reducing yields by as much as 50%; this could be a potential loss of millions of dollars to Arkansas. The overall objectives of this research were to determine how the fungus initiates infection of plants and how the pathogen survives to cause disease each year. We also began a search for resistance to the disease. Our goals were also to find an effective chemical treatment that could be used to control the disease until resistance is found.

#### Action

Based on observation, spores infect roots; therefore, a molecular technique called PCR was developed to 'track' the fungus within asymptomatic plants. When roots, soil and flowers were inoculated with spores of the fungus and plant tissues examined using PCR, the fungus had infected roots directly from infested seeds and from soils. PCR is an extremely useful tool to measure how this fungus invades plants. A fungicide, registered on another crop, effectively reduced infection of rice by false smut. In 2009, comparative field and greenhouse studies on seed treatments with fungicides across several locations indicate that fungicides applied to seeds prevented infection of seedlings. Field tests with healthy seeds planted in infested soils suggest that seedlings were infected by resident spores found in soils even after two years.

#### Impact

Results clearly show for the very first time how the fungus

infects rice. The fungus is seed transmitted and fungal spores can survive in soil. The disease cycle is better understood. Infection often occurs asymptomatically. Infection also results in blanking of panicles produced by infected plants and the production of spore bodies on the panicles. It has been demonstrated that seed treatments work against this important disease and spores found in fields are capable of causing this disease.

We now understand how rice is infected by this fungus allowing us to develop more effective and more targeted strategies to manage the disease and to reduce the dispersal and importance of an emerging disease of rice in Arkansas. The results may also influence how producers grow rice for commercial distribution in fields with a history of this disease.

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#### Funding

This research supported by the Arkansas Rice Research and Promotion Board and the University of Arkansas Division of Agriculture, Arkansas Agricultural Experiment Station

#### Anthracnose diseases of grain sorghum

#### Issue

Arkansas continues to rank high in the U.S. in the annual production of grain sorghum. Grain sorghum also has intrinsic value as a rotation crop to help producers control weeds, insects, and plant diseases. However, yields per acre in the state have remained relatively low compared to other regions. Many plant diseases affect grain sorghum, reducing both yield and grain quality. In some areas of the state, yield losses due to diseases may range from 10-50% each year. Anthracnose, caused by a fungus *Colletotrichum sublineolum*, is one of the most important diseases of grain sorghum in the state resulting in crop failure.

#### Action

The objectives of this study were to develop comprehensive management strategies and techniques and make them available to our producers to correct for the lack of information on grain sorghum pathology in Arkansas. Selected hybrids and experimental breeding lines of grain sorghum were evaluated on four University of Arkansas Division of Agriculture experiment stations in the Delta region. The populations of the sorghum anthracnose pathogen in the state were examined to find out why so many different hybrids were being infected by this devastating fungus.

#### Impact

Information on the best management practices for production of grain sorghum is useful by providing reliable information to growers about the hybrids and practices that minimize the importance of diseases while increasing their yields and profit. The results of this work demonstrate that there are nearly a dozen new and extremely virulent races of the anthracnose fungus in Arkansas that have never been described in the literature. These new races not only infected all known hybrids but were responsible for the outbreaks in Arkansas reported each year. The data published in recent years clearly show that yields can be significantly reduced within a range from 10% to more than 90% across the varieties and races in the state. These data support the observations that resistance was inadequate to control this disease within the state. The research also demonstrated that stakeholders can grow sorghum and produce high yields with a simple solution. Simple rotations and careful selection of hybrids are recommended as effective ways to reduce the significance of diseases on grain sorghum in production to achieve yields greater than 10,000 lb/ acre.

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#### Funding

Research supported by the University of Arkansas Division of Agriculture, Arkansas Agricultural Experiment Station and the Corn and Grain Sorghum Research and Promotion Board

### New Rubus virus diseases discovered

#### Issue

Sixteen new *Rubus* (blackberry and raspberry), viruses have been discovered in the past few years. The majority of these viruses have been identified by the PI and his collaborators and were found in association with two diseases: blackberry yellow vein (BYV), an emerging disease in the mid- and Southeast and crumble fruit and decline (CFD), a limiting factor for the cultivation of raspberry in the Pacific Northwest.

#### Action

A major effort is underway to identify all viruses associated with BYV and CFD in all areas where the diseases are widespread. This work involves virus purifications, next generation sequencing and bioinformatical analyses of the virus genomes followed by development of detection protocols. The next step is to study the epidemiology of the viruses. This includes identification of virus vectors, their geographic distribution and the time of transmission under field conditions.

#### Impact

New knowledge on the epidemiology of the viruses associated with BYV and CFD is of utmost importance as both diseases are caused by virus complexes the identity of which changes depending on the geographic area. The ultimate goal of this study is to identify the predominant viruses in each area and their major vectors and implement measures that will eliminate vectors and sequentially diseases.

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#### Funding

USDA Specialty Crops Research Initiative; University of Arkansas Division of Agriculture

### New soybean disease discovered

#### Issue

A new soybean disease, vein necrosis, has emerged in major production areas in the United States. The disease was found in Arkansas, Mississippi, Tennessee, Illinois and Kansas in high percentage of the fields surveyed. The wide distribution of the new vein necrosis makes it a potential threat for soybean production in the central and southeastern United States.

#### Action

A new virus is associated with soybean vein necrosis. It has been found in all plants with typical disease symptoms. The causal agent belongs to the genus *Tospovirus*, a group of viruses transmitted by thrips. The mode of transmission of these viruses and the lack of efficient methods to control thrips make tospoviruses important pathogens of several crops as they have the potential to rapidly spread in large areas. The genomic sequence of the virus has been completed and isolate variability investigated. The data were used to develop and validate detection methods for rapid and sensitive detection of the virus. Molecular and bioinformatic approaches will lead towards understanding the virus and its movement in the plant and the field.

#### Impact

The discovery of the new virus associated with leaf necrosis in soybean may be an emerging problem for the crop. The virus may pose a significant threat to the industry as the putative vectors – thrips – are significant pests in the field and they may be able to cause an epidemic if left uncontrolled. The virus does not belong to any of the established groups within the *Tospovirus* genus and our studies can shed light in the evolution of this important insect and plant pathogenic group of viruses.

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## Causal agent of rose rosette identified

#### Issue

Before any control measures can be implemented it is important that we understand the ecology and epidemiology of the pathogens affecting a crop. One of the most elusive plant diseases has been Rose rosette, a disorder reported for the first time almost 70 years ago. Rose rosette affects roses from the East to the West Coast and can cause significant losses for the ornamental industry because of the unmarketability of affected plants.

#### Action

The causal agent of Rose Rosette has been identified and fast and sensitive detection methods has been developed for the agent, a new virus. Using the new tools we are able to test for alternative hosts that can harbor the virus and function as a reservoir for future infections.

#### Impact

Rose rosette has caused significant losses in the ornamental industry and the affected area is expanding rapidly. The disease has a latent period of about a year, during a time that eriophyid mites, vectors of the Rose rosette virus, can transmit the virus to healthy plants in nursery or greenhouse settings. The newly developed detection protocols can provide fast and reliable identification of infected plants. This will have an important effect in the management of the disease as affected plants can be eliminated from the system and avoid further dispersal through propagation material or/and mites.

Rose rosette virus has a unique phylogenetic placement within negative sense RNA viruses and its further study has the potential to give answers about the evolution of the emerging genus *Emaravirus*.

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University of Arkansas Division of Agriculture

# Activities of the urban plant pathology program in Arkansas

#### Issue

The scope of urban plant pathology in Arkansas is very diverse, involving native and introduced disease pests that can directly impact all citizens of the state. These plant disease pests pose both direct and indirect threats to agricultural commodities of Arkansans. The urban plant pathology program focuses on education of homeowners, agriculturists, youth, the professional landscape, turf, and nursery industries. The establishment of a single source of disease related information for urban populations throughout the state will reinforce the genuine need.

#### Action

Program goals are achieved through county and state educational programs such as demonstrations, applied research, education booths, presentations, publications, newsletters, web pages, in-service training of county faculty, and news releases.

The "Pest Guys" Web page was developed for the University of Arkansas Division of Agriculture Cooperative Extension Service Web site to allow the opportunity for growers and others to submit questions to a plant pathologist, entomologist, or weed specialist. This position is responsible for the inception/ management of the site. The Web site had its first full season debut in the spring of 2008, where it received more than 10,000 hits for people in-state and out.

#### Impact

The activities of the urban plant pathology program are specific to Arkansas and its agricultural component. Plant disease education programs are presented to all interested counties that have an agricultural sector. The urban plant pathology program is aimed to connect and help the citizens of Arkansas and agriculture through service and education on those topics relating to plant diseases.

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#### Funding

University of Arkansas Division of Agriculture

### **Rice policy and market analysis**

#### Issue

The U.S. rice industry provides both domestic and international market supplies of high quality rice. This is particularly true in Arkansas, the leading rice-producing state, where as many as 1.5 million acres are planted to rice. Arkansas rice producers are particularly vulnerable to instability in domestic and international rice prices and costs of production. In a number of recent years Arkansas rice producers have depended heavily upon the price and income supports of the U.S. federal government to provide income and market stability. The potential for reduction in support levels in response to federal deficits, WTO dispute rulings and Doha round proposals has become a threat to maintaining the safety net for Arkansas and U.S. rice producers. Rice is the most trade-distorted crop exported by the U.S. due to protectionist policies by many Asian and European countries who protect their producers and consumers to achieve food security objectives. The rice market is particularly unstable because it is subject to 1) the Asian monsoon weather, 2) high levels of trade protection and 3) a high degree of market segmentation based on product differentiation at the production, processing and consumption levels. Market participants need market and policy analysis on a regularly updated basis to understand changes that influence prices, production, and consumption patterns.

#### Action

The Arkansas Global Rice Project (AGRP) monitors and analyzes market and policy events in the global rice economy. Baseline10-year projections of the major rice producing, consuming, and trading nations are developed on the basis of a supply and demand simulation model, AGRM (Arkansas Global Rice Model). This framework provides estimates of production, consumption, trade, prices and stocks based on historical supply and demand relationships, policies, and macroeconomic variables such as population and income growth. The model has been used in the past year to evaluate impacts of alternative bio-fuels policies and the role of policy in explaining the extraordinary high price spikes in global rice prices in 2008. A spatial equilibrium model, RICEFLOW, which estimates country-to-country differentiated rice trade flows by rice type and degree of milling is also maintained. This model is particularly useful to evaluate regional trade agreements and transportation and other transaction cost impacts.

#### Impact

The research on the global rice economy and analysis of trade protection has received considerable attention from the World Bank, the United Nations, the U.S. Congress and many policy decision-makers in the U.S. and the rest of the world. Numerous presentations were made in 2009 to present the prospects of trade liberalization and challenges facing the U.S. and global rice economies. Domestic and international agencies (USDA, ERS and FAFRI, Iowa State University and University of Missouri, the World Bank, OECD, FAO, and the Government of Japan) have requested assistance from the Arkansas Global Rice Economics team in developing their rice market analysis. Our analysis is unique due to its recognition of both long and medium grain rice markets, which no other research group conducts. It is unique because we are not constrained to use 'official' government data or policies in our analysis and therefore maintain a greater degree of objectivity. The beneficial outcomes of our models include better production, processing, and consumption decisions by market participants and better policy decision-making by the U.S. and foreign governments.

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#### Funding

USDA, CSREES and the Arkansas Rice Research and Promotion Board; University of Arkansas Division of Agriculture

# Starch structure and properties of barley affect malting and brewing performance

#### Issue

Brewing performance is primarily influenced by barley quality, malting process, and adjuncts. The objective of the brewer is to maximize the extract through malting, cooking and mashing, which is subsequently converted into alcohol by yeast fermentation. Barley malt is the main source of fermentable sugars in addition to providing enzymes to hydrolyze the starch into simple sugars. Malt quality is subjected to variations from genetic, environmental, and malting conditions. The current malt specifications are not always reliable to predict malt brewing performance, and most malting barley breeding programs emphasize on increasing  $\alpha$ -amylase and diastic power.

### Action

Food science researchers at the University of Arkansas

Division of Agriculture have shown strong correlation between malting variables and brewing performance. Thirty-five wort samples prepared with malt from different malting barley varieties and conditions using a micro-malting process were analyzed to be correlated with malting variables and brewing performance predicators (Extracts, and real degree of fermentation). The results show that steep conditions, barley variety, and particle size had the most profound impact on Extracts/ real degree of fermentation. Merit (2-row barley) was associated with higher Extracts, glucose content, and soluble solids in wort than Tradition (6-row barley). Fine particle size was associated with significantly higher Extracts and glucose content than coarse particle size for both barley varieties.

#### Impact

This work demonstrates that wort composition may be used to predict brewing performance and the important contributions of barley starch composition and structure to brewing. The work also provides new information for selecting barley with better brewing performance. The development of a more rapid and specific method to evaluate malt performance will facilitate the screening of malting barley varieties.

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#### Funding

Busch Agricultural Resources LLC; University of Arkansas Division of Agriculture

# Economics of zero-grade rice and land tenure

#### Issue

The majority of rice acres in Arkansas are flood irrigated using contour levee systems. Contour levee rice fields require large amounts of applied water to maintain a flood during the production season. Fields precision leveled to a zero grade require significantly less applied water and provide significant savings in annual production expenses relative to contour levee rice fields. However, zero-grade is a land improvement and requires a large initial capital investment. The landowner would generally be responsible for the initial investment in leveling the field to a zero grade, but the tenant would receive the benefits of the lower production costs and ease of management. This study uses a Net Present Value (NPV) approach to evaluate the monetary benefits of zero-grade rice production for tenants and landlords under alternative rental arrangements.

#### Action

Precision leveling costs are calculated based on a 40 acre field assuming a \$1.60 per cubic-yard custom hire charge and a soil removal rate of 350 cubic yards per acre. Charges for construction of a drainage ditch around the field, drainage pipes, and application of poultry litter to cut areas are also included. Returns above production expenses are calculated for both a rice-soybean rotation under contour levee management (before the land improvement) and a continuous rice rotation

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under zero-grade management (after the land improvement). Returns are split between the landlord and the tenant based on the terms of common rental arrangements used in eastern Arkansas. Three yield scenarios are modeled: 1) a 10 percent yield gain, 2) a 0 percent yield gain, and 3) a 20 percent yield loss after the land improvement. Yields for scenario 3 are assumed to equilibrate to normal in year six. Annual cash flows (returns after the improvement less returns before the improvement) are discounted assuming a 6 percent discount rate. The initial capital cost of zero grading (\$829 per acre) is assumed to be captured in increased land value for the land owner in a one-to-one fashion based on consultation with eastern Arkansas agricultural appraisers. Landlord and tenant NPVs of discounted annual cash flows are calculated for alternative planning horizons (years) and alternative tenure arrangement terms before and after the land improvement.

#### Impact

Results from this study indicate that both parties gain positive monetary benefits from zero-grade under most lease structures. The tenant tends to gain the most monetary benefit when the terms of the lease agreement remain unchanged before and after the land improvement, while the landlord tends to receive the most monetary benefit by renegotiating for a larger share of the crop or in some instances renegotiating from a crop share to a cost share arrangement. The potential for yield loss after leveling to a zero grade can negatively impact both parties during the initial years following the land improvement. Both parties can receive negative NPVs for some lease structures when yields decline by as much as 20 percent following the land improvement. However, NPVs eventually become positive with the passing of time. Therefore, zerograde has potential to increase the risk of yield and income loss for both parties in the short run but has potential to increase returns for both parties in the long run.

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#### Funding

Arkansas Rice Research and Promotion Board; University of Arkansas Division of Agriculture

### Grasses as dedicated bioenergy crops

#### Issue

Grasses that have high biomass yield can serve as feedstocks for producing biofuels. Arkansas has great potential for producing biomass from its grasslands, cropland, and forests; however information is lacking on performance of varieties, response to nitrogen fertilizer, minimum plant densities needed to assure high yields, effective herbicides for controlling weeds during establishment, and the timing of maximum yield in relation to changes in quality of the biomass.

#### Action

We have discovered large differences in biomass yield potential of switchgrass between a site in northwest Arkansas on a former pasture and a site in east-central Arkansas on former row-crop land. The latter produced much lower yield, probably because of a restricted rooting zone and low subsoil fertility. We created a growth curve of switchgrass that identified August as the month of maximum biomass accumulation, with only about 10% yield loss from August to January. No significant differences in biomass yield were detected by applying increasing rates of poultry litter or urea fertilizer to switchgrass. Several herbicides were identified that permitted superior establishment of switchgrass in a no-till method of planting into a permanent meadow.

#### Impact

The large difference in biomass yield between the two test sites indicates that subsoil disruption to break natural soil pan and a plow pan would likely benefit switchgrass yields. Growth curve data indicated that switchgrass stands can remain standing in the field even after end-of-year senescence with minimal yield loss through mid-January. Harvest will have to be delayed until December before the standing biomass moisture content declines below 20%, a level considered safe for direct chopping and storage. Growth data were used to modify ALMANAC, a crop simulation model, to improve its accuracy in predicting biomass yield in other locations in Arkansas. Such a model will be useful for a future bioenergy industry to plan the location and timing of harvests to meet biofuel production needs.

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#### Funding

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## A Healthy Well-Nourished Population

## Role of functional foods in combating obesity

#### Issue

Obesity is a multifactorial condition and a major public health concern affecting all demographic segments of the population, independent of race, culture, and/or ethnicity. For decades obesity has been an epidemic in the United States, and the proportion of overweight and obese adults in the population continues to rise. An alarming 34% of adults in the U.S. are currently obese, which is significantly greater than was reported a decade ago. Although, obesity is a major health problem in the U.S., there are no proven, long-lasting, and widely applicable approaches to weight loss.

#### Action

We are conducting animal studies that are evaluating the role of functional foods such as blackberries, soybeans, fructooligosaccharides, and conjugate linoleic acid in the prevention of chronic conditions associated with increased body weight.

#### Impact

Positive findings of the study would help reduce the complications associated with excess body weight. This will translate to decreased burden on our health care costs and loss of productivity costs. Furthermore, the findings are of commercial interest because soybeans and blackberries are important crops in Arkansas.

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#### Funding

Arkansas Biosciences Institute; University of Arkansas Division of Agriculture, Institute of Food Science and Engineering

# The role of anti-oxidant rich berries in the prevention of smoking-induced bone loss in postmenopausal women

#### Issue

The prevalence of bone loss is greater in women than in men and 25-30% of women experience bone loss, which results in major orthopedic problems. In the United States, a conservative estimate is that nearly half of all women over the age of 50 will suffer an osteoporosis-related fracture, resulting in more than 1.5 million fractures a year including painful vertebral fractures. Fractures in postmenopausal women represent a major health problem. Hence, osteoporosis-related fractures are an enormous health problem with immense socioeconomic implications.

#### Action

We are conducting a clinical trial to evaluate the extent to which smoking induces bone loss in postmenopausal women. Additionally, the role of blackberries and blueberries in the prevention of smoking-induced bone loss is being evaluated. This is one of the first studies to look at the role of berries on bone loss in smokers. Phytochemical-rich berries can protect bone by scavenging free radicals involved in the etiology of smoking-induced bone loss.

#### Impact

The cost of fractures in the United States is currently estimated at \$19 billion annually and is projected to exceed \$60 billion by 2020. By reducing bone loss, we can reduce the incidence of fractures and thereby lower health care costs and improve the quality of life. Additionally, food industry can benefit from these findings by incorporating these fruits in food products and marketing them as beneficial health food products.

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Arkansas Biosciences Institute; University of Arkansas Division of Agriculture

### The role of rice in the prevention of bone loss in a rat model of postmenopausal osteoporosis

#### Issue

Over the past several years, clinical trials have demonstrated that drug therapies reduce the risk of osteoporotic fractures among postmenopausal women. Although there are several treatment options for osteoporosis, their efficacy may differ, and effectiveness depends partly on compliance. There is evidence that many women do not continue and/or adhere to long term therapy as they are associated with several side effects, hence an efficacious dietary supplement as an alternative to a prescription drug is highly attractive. Among the staples, rice is one of the richest sources of plant sterols, oryzanol and vitamers of E such as, tocopherols and tocotrienols, which may protect against bone loss. However, bone protective properties of rice are yet to be explored.

#### Action

To our knowledge, the osteo-protective effects of rice have not been investigated. Therefore, this study is designed to evaluate the extent to which different types of rice prevent bone loss in a rat model of postmenopausal osteoporosis. The results of this study can serve as a foundation for testing the efficacy of rice and its constituents in increasing bone mass and quality in postmenopausal women and thereby prevent osteoporosis.

#### Impact

Arkansas is the leading producer of rice in the country. If the findings of this study are positive, it can greatly benefit rice producers and processors in the state. Furthermore, it will provide women with a novel therapeutic option that is natural and safe to prevent bone loss.

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#### Funding

Research Incentive Grant, University of Arkansas Division of Agriculture, Institute of Food Science and Engineering

### Efficacy of PTH-CBD to increase bone mineral density and bone microarchitecture in an osteoporosis restoration model

#### Issue

Osteoporosis continues to be a major health burden and the treatment options that are available for osteoporosis are associated with several side-effects and are not suitable for all.

#### Action

Scientists in the University of Arkansas Division of Agriculture and University of Arkansas Biochemistry department are conducting animal studies to demonstrate the efficacy of a novel compound PTH-CBD in the treatment of postmenopausal osteoporosis. PTH-CBD is a fusion protein of parathyroid protein (1-33) and immunologically inert collagenbinding domain (CBD). PTH-CBD binds to type 1 collagen and able to stimulate cAMP accumulation via signaling PTH/ PTHrP receptor. PTH-CBD is shown to be anabolic in bone as it increases BMD and alkaline phosphatase levels. The increase in BMD is greater than bisphosphonates currently available in the market. PTH-CBD is very potent and results in more prolonged effect on bone mineral density (BMD) than PTH (1-34). Objectives of this study are to determine the efficacy of PTH-CBD to increase BMD and to determine its influence on bone micro architecture in an animal model of postmenopausal osteoporosis.

#### Impact

When the above listed studies are completed, we can establish the efficacy of PTH-CBD in the reversal of bone loss in a rat model of osteoporosis. The next step would be to test it in primates. Several drug companies are interested in the outcome of the study; a provisional patent on this was filed by University of Arkansas.

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Arkansas Biosciences Institute; University of Arkansas Division of Agriculture

# How to motivate parents to promote intake of calcium-rich foods among early adolescents

#### Issue

Osteoporosis, a disease of the elderly, is most commonly connected to calcium; however it is not generally regarded as a childhood disease. Yet, the origins of osteoporosis putatively occur at the much younger age of 10 to 13 years during the period of peak bone acquisition. Parents and caregivers are a dominant influence on eating and activity behaviors of early adolescents and therefore play an essential role in preventing osteoporosis by promoting intake of calcium-rich foods (CRF). However, few messages about improving CRF intake among early adolescents are directed to the parent's role. Little is known about what the content of these messages should be, how they would be perceived, and whether they would motivate parents to promote CRF to early adolescents. Key messages could address motivation and/or benefits to behavior change, barriers and strategies to enable parents to promote CRF intake among early adolescents.

#### Action

Given that little has been done to determine which messages would resonate with parent audiences regarding their role in promoting intake of CRF for their children, through this regional project, we propose to fill this void through qualitative methods. Risk communication literature and social marketing concepts indicate that behavior change involves understanding perceptions and motivations concerning the behaviors of interest. Qualitative research methods provide data that can only come from the persons engaged (or failing to engage) in the behaviors. Understanding whether parents perceive that their child is susceptible to risk from consuming diets low in CRF as well as the belief systems that influence those perceptions are needed to craft messages and develop programming that will motivate parents to change behavior.

#### Impact

A multistate perspective will provide greater abilities to recruit a wide representation of the sample population, which is not feasible for groups working within a more narrow geographic reach. Studying a population from multiple states with diverse demographic characteristics will provide a rich database from which to identify motivations and test messages based on factors that may promote intake of calcium rich foods by early adolescents. This will help in the prevention of osteoporosis.

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W-2003 regional research project group

#### Funding

University of Arkansas Division of Agriculture, Agriculture Experiment Station, USDA

### Study to gather data on relationships between body mass index (BMI), perception of body image, and obesity

#### Issue

Overweight and obesity have reached epidemic proportions in the United States. Recent reports indicate that Arkansas ranks seventh in incidence of obesity with more than 63% of adults and 37% of school children being overweight or obese. Young females are reported to have more negative perceptions of body image than do young males. These negative perceptions are beginning at a younger age. Because obesity is a major health problem that frequently begins in childhood and adolescence, it is important to provide interventions to prevent inappropriate eating behavior. A longitudinal study has been designed to gather anthropometric and survey data to: (1) correlate body mass index (BMI), percent body mass index and body image with obesity in pre and post pubescent females in rural Arkansas communities; (2) determine if BMI is the most appropriate tool for evaluating weight status in growing children and young adolescents; (3) determine if a low BMI is an indicator of appropriate lifestyle and eating behavior; (4) determine if a high BMI is an indicator of inappropriate lifestyle and eating behaviors; (5) determine if young girls perception of their body type or image changes as they go through puberty; (6) determine if changes in body perception can be a predictor of inappropriate eating behaviors; and (7) determine the differences in BMI, body fat and body image in ethnically diverse populations living in rural communities.

#### Action

Two hundred and thirty-six (236) college age students participated in the pilot study. Of those, 206 were female and 25 were male with 80 being 10-19 years of age, 128 being 20-22 years of age and 23 subjects being over the age of 23 years. Ethnic diversity was lacking was lacking in this group of volunteers with 86% being white and 14% being non-white. Data analysis revealed that as BMI increased so did the age of the participant and as BMI increased participant dissatisfaction with muscle tone and definition, body proportions, weight and mean BIQ increased. Significant differences were also found between body shape (p < 0.001) and BMI indicating that as BMI increased, body shape increased.

The researcher evaluated the body shapes of the participants to be significantly larger than the participants' self-perceptions. The results of this study indicated that participants who were in the overweight and obese BMI categories reported greater dissatisfaction with muscle tone and definition, body proportions, weight, physical coordination and mean BIQ than did the participants in the underweight and normal BMI categories. As the self-selected body silhouette increased in size respondent dissatisfaction with muscle tone and definition, weight and mean BIQ increased. Respondents who indicated that silhouette 2 most closely matched their body shape were significantly more satisfied with their body proportions than those respondents selecting silhouettes 3 or 4.

#### Impact

Participants in this study appeared to understand the relationship between BMI and the muscle tone and definition, body proportions, weight, and physical coordination. This may be a reflection of a number of factors. The current popularity of television programming and advertised weight loss programs promoting losing weight to become healthy may contribute to these results. Additionally, our state requires that parents and students in public schools receive annual or bi-annual "BMI Report Cards". Some of the first recipients of these Report Cards now attend our university, which may affect theses results. Additionally, over the last several years the wellness program at our university has developed and implemented an educational program that emphasizes healthy eating habits, exercise and the relationship of body image to diet and exercise. It is possible that the findings of this study reflect the results of this effort.

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University of Arkansas Division of Agriculture

### Evaluation of dietary supplement safety

#### Issue

The use of dietary supplements, which includes vitamin and mineral products and botanicals, remains popular in the United States and worldwide. The use of these products varies. In many parts of the world they are used as folk medicines but in the United States they are used both nutritionally and pharmacologically. Current dietary supplement regulations in the United States allows for products to be marketed and sold in a manner that may place consumers at risk. There are numerous reports in the medical literature documenting adverse events. Likewise, even the folk use of dietary supplements worldwide has been associated with problems. Therefore, it is necessary to evaluate the safety of these products in order to allow consumers and healthcare providers enough information to make informed decisions regarding dietary supplement use. Many of the adverse events are associated with products that are contaminated or used inappropriately. These issues can be reduced or eliminated by an ongoing evaluation of dietary supplement safety.
#### Action

The proper evaluation of dietary supplement safety requires laboratory research, human clinical trials and consumer education. All of these approaches are being conducted. Botanicals such as chamomile, echinacea and herbal products from Kenya have been studied for microbial contaminants. Whey protein powders that are used as sports nutrition supplements have also been evaluated for contaminants. A database of adverse event reports that will assist medical professionals with safety concerns has been developed. Results from all of these projects have been presented at professional meetings in the United States and in Africa. The results have also been submitted to professional scientific journals for publication.

#### Impact

Evaluating the safety of dietary supplements has benefitted consumers, healthcare providers and industry. Results and conclusions from this work have been incorporated into training materials for medical professionals and product formulation changes have occurred in several of the products that have been evaluated. Continuation of this work will allow regulatory agencies to develop and enforce appropriate standards for the use of the products and help industry to maintain or develop consumer confidence in these products. Consumers will continue to use these products as long as their safety and efficacy is appropriately conveyed.

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#### Funding

University of Arkansas Division of Agriculture

# Jasmonate effects on vitamin C levels in plants

#### Issue

Vitamin C (ascorbate) is the most abundant water-soluble antioxidant in plants, and also an important dietary requirement for human health. Ascorbate provides the first line of defense in plants against damaging reactive oxygen species that can be generated by many different stresses, such as wounding, ozone, high salinity, and pathogen attack. Previous results have shown that ascorbate levels in certain crops decrease in response to insect damage or mechanical wounding, and may also be influenced by jasmonates, a class of hormones that mediate how plants respond to wounding and herbivory. The goal of this project is to understand how wounding influences ascorbate levels in plants, and what role jasmonates play in this process.

#### Action

We explored the impact of wounding and application of jasmonates on ascorbate levels in two plant species (tomato and *Arabidopsis*), and also studied the impact of wounding on ascorbate metabolism in mutant lines of both species that are defective in jasmonate synthesis or perception. We found that both the application of jasmonates and the mutations that impair jasmonate signaling affected ascorbate levels in foliage of both tomato and *Arabidopsis*, suggesting that jasmonates may regulate steady-state ascorbate metabolism. However, the impact of wounding on ascorbate levels was similar in jasmonate mutants and wild type controls, indicating that this wound response does not require jasmonates. Further studies will explore the potential role of other wound-responsive hormones, such as ethylene and abscisic acid, in regulating the impact of wounding on ascorbate metabolism.

#### Impact

Our findings indicate that the effects of wounding and jasmonates on ascorbate accumulation differ between plant species; both of these factors increase ascorbate levels in *Arabidopsis*, but depress ascorbate levels in tomato. Further studies will investigate how *Arabidopsis* maintains high ascorbate levels when wounded. This information should aid in developing means to counteract the detrimental effects of herbivorous insects and other sources of mechanical injury on antioxidant levels in crops such as tomato, thus influencing the knowledge about health benefits from antioxidants in crops, such as tomato.

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#### Funding

Plant Powered Production (P3) Center through the RII Arkansas ASSET Initiative (AR EPSCoR), funded by NSF grant # EPS -0701890; University of Arkansas Division of Agriculture

## Marinade treatment can eliminate irradiation effects on chicken meat quality

#### Issue

Irradiation represents an effective means of reducing bacterial contamination of poultry meat but results in unwanted sensory quality defects that limit its desirability. These sensory defects include increased rate of lipid oxidation and the formation of a pink color that persists after cooking. Both of these defects exhibit a dose-dependent relationship with the absorbed irradiation dose strength. Increased rate of lipid oxidation leads to off-flavors and -odors and is the result of radiolytic water products and reactive oxygen species that are created during the irradiation process. Previous research was aimed at reducing the irradiation dose necessary to achieve an adequate level of pathogen destruction through the incorporation of tartaric acid and grape seed and green tea extracts. These compounds have been shown in model system to act as bacterial inhibitors. Grape seed and green tea extracts are rich sources of polyphenolic compounds, which have been shown in numerous studies to have antioxidant activities. Both organic acids and these plant extracts have generally recognized as safe (GRAS) status and may be regarded as "natural" additives. Tartaric acid confers a "tart" flavor to food products that could potentially affect the willingness of consumers to buy chicken products in which tartaric acid has been added. Therefore, the use of tartaric acid and grape seed and green tea extracts in a chicken marinade needs to be subjected to consumer testing to determine the acceptability of the product to consumers.

#### Action

Tartaric acid and a combination of grape seed and green tea extracts were incorporated into boneless/skinless chicken breast meat via vacuum-tumble marination. The marinated samples were then transported to Iowa State University and irradiated by electron beam irradiation at 0, 1.0 and 2.0 kGy. Upon return to our facility in Fayetteville, AR, the irradiated and treated samples were stored fresh at 4 °C for 12 days and in frozen storage for 9 months and their physicochemical characteristics assessed.

A consumer test was designed to investigate the effect the incorporation of tartaric acid and grape seed and green tea extracts on consumer acceptance of marinated chicken breast meat. Seventy consumers participated in the consumer study and were asked to assess 6 chicken breast samples from the various treatments and rate them for overall texture, flavor, and appearance, as well as tenderness and juiciness. Demographic data were also collected.

#### Impact

The incorporation of tartaric acid and grape seed and green tea extracts into chicken meat before irradiation has the potential to reduce the effects of irradiation on meat quality and shelf life. This can be accomplished by reducing the irradiation dose strength needed to achieve adequate pathogen destruction and thereby reducing the irradiation-induced quality defects and, by acting as antioxidants, further reduce the negative effects of irradiation on the chicken meat quality. The results of this work show that the incorporation of these compounds into a marination applied through vacuum infusion reduces the rate of lipid oxidation and did not significantly alter the texture, pH, or WHC of the chicken meat. The consumer acceptance study of chicken breast meat treated with these compounds clearly shows that consumers, overall, were unable to differentiate treated and irradiated samples from the controls.

#### Contact

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#### Funding

Food Safety Consortium; University of Arkansas Division of Agriculture

## Pentapeptide isolated and characterized from rice bran inhibits multiple cancer cell proliferation

#### Issue

The chronic diseases account for 7 of every 10 deaths and affect the quality of life of 90 million Americans each year. Cancer remains as the second leading cause of death in the United States. Some cancer patients are supplementing traditional health care with nutraceuticals and functional foods.

Rice bran protein has the potential for creating antihypertensive and anticancer peptides. There are no systematic studies reported on the production of bioactive peptide(s) against cancer from commercially available heat stabilized defatted rice bran by proteolytic enzyme hydrolysis and, particularly their resistances to gastrointestinal environment. Therefore, a systematic study on the production of gastrointestinal resistant peptide(s) from HDRB by enzymatic hydrolysis, and testing for anticancer activity is needed.

#### Action

In this research, rice bran peptide fractions obtained by enzymatic hydrolysis followed by gastrointestinal juices treatments, and fractionation yielded peptide fraction (<5kDa) that was able to inhibit the growth of cancer cells. Full characterization using purification and mass spectrometric techniques resulted in isolation of a pentapeptide (Glu-Gln-Arg-Pro-Arg) from rice bran to have inhibitory activities (70-80%) on human colon, liver, lung and breast cancer cell lines in vitro.

#### Impact

This study has provided the basis for developing novel gastrointestinal environresistant bioactive peptides active against different cancer cell types from heat-stabilized de-fatted rice bran (HDRB), an underutilized and inexpensive co-product of rough rice processing. The significance of the findings suggest that bran could bear positive impact on human health through its protein components providing potentials for advancement in medicinal application from an agricultural standpoint, while it is considered as a co-product of a larger process. Successful utilization of data from this research will revolutionize the concept of preparing peptides with bioactivity against human cancers and promote further study of value-added products from the cereal grains like rice bran.

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Funding

ABI; University of Arkansas Division of Agriculture

## The effect of thermal processing methods on the health benefits of procyanidins in blueberries

#### Issue

Blueberries are a rich source of procyanidins, compounds which have received much attention due to their important role in health promotion. Procyanidins have been shown to exhibit antioxidant, anti-inflammatory, anti-hypertensive, and anti-allergy properties, in addition to their ability to regulate enzyme activities, gene regulation and cell signaling pathways. Blueberries are commonly prepared and consumed in various processed forms including canned whole berries, juices, and purees. Unfortunately, information is lacking on how different thermal processing methods and subsequent storage of processed products influences the procyanidin composition and content of blueberries.

#### Action

This study evaluated changes in procyanidin composition and content in response to thermal processing and storage of clarified and non-clarified juices, berries canned in water or

syrup, and purees. Berry products sampled one day after processing and after 1, 3, and 6 months of storage were analyzed for procyanidins by HPLC. Processing blueberries into various processed forms resulted in significant losses of total procyanidins, with only 19% and 23% being retained in non-clarified and clarified juices, 41% retained in purees, and 65% and 78% being retained in berries canned in syrup or water. The smaller procyanidin monomers and dimers were retained to a much greater extent than larger oligomers in all products following processing. Procyanidins were further degraded during 6 months of storage, with only 8% and 11% retained in clarified and non-clarified juices, 7% retained in purees, and 22% and 32% retained in berries canned in syrup or water. Similar to results obtained following processing, smaller procyanidin monomers and dimers were better retained than larger oligomers.

#### Impact

Processed blueberry products have much lower levels of health-promoting procyanidins than fresh blueberries, with whole canned berries retaining the highest amounts, followed by purees and juices. Methods are needed to prevent procyanidin losses during processing and storage. Additional studies are needed to determine if the marked losses of procyanidins in processed products has an adverse effect on health outcomes.

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#### Funding

University of Arkansas Division of Agriculture

# Anti-colon cancer effect of soy saponin fractions in soybean

#### Issue

Colon cancer is the third most common cause of cancer death in the United States in 2008, accounting for 9% of all cancer deaths. Research is needed to determine potential nutraceutical and pharmaceutical benefits of food products relative to colon cancer.

#### Action

We are evaluating the effects of natural elicitors at various concentrations on saponin contents in different soybean cultivars. Soy saponin fractions will be purified to examine for their therapeutic potential. Additionally, animal studies will be conducted to determine the response of colon tumorigenesis to soy saponin fractions by assessing biomarkers of colon cancer. Soybean saponins can enhance health benefits, especially anticarcinogenic activity.

#### Impact

The application of natural elicitors may enhance phytochemicals in soybean, especially saponins, and the role of soy saponins in the prevention and treatment of colon cancer, thereby contributing to our understanding of soy saponin fractions as an alternative to synthetic therapeutic agents. The findings of this study will provide efficacy for soy breeders and producers in developing soybean lines with nutraceutical and pharmaceutical utilities and valuable data on the biological or biomedical activity of purified soy saponins.

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#### Funding

Arkansas Biosciences Institute; University of Arkansas Division of Agriculture

# Healthy conjugated linoleic acid (CLA)-rich soy oil produced by a new pilot plant scale method

#### Issue

Dietary CLA is well recognized for its anti-carcinogenic, anti-atherogenic properties and ability to increase lean body mass and protect against immune induced body wasting disease, chronic inflammatory diseases and cancer. Dairy and beef products are regarded as the primary source of naturally occurring CLA at levels at 0.2-2% in milk-fat or beef-fat. However, the current human intake of CLA is proposed to be 10 times less than the 3g/day minimum value proposed to have optimal human health benefit, as extrapolated from animal studies. Obtaining this level of CLA from naturally occurring sources of beef and dairy products would increase the total fat and saturated fat intake and increase the negative health risks associated with dietary saturated animal fats. The production of a more concentrated CLA source in a readily available food with minimal saturated fat would therefore be beneficial. Sov oil is an obvious candidate to make CLA rich oil as it consists of 50% linoleic acid (LA) from which CLA is made. It is relatively low in saturated fat and is the most commonly used oil in the U.S.

#### Action

We have produced a 20% CLA- rich soy in 12 hours using a novel processing technique that uses ultraviolet light to convert soy oil LA to CLA.

Soy oil was shown to be the most viable LA-rich oil for CLA production. Animal nutrition studies showed that the oil would be an effective dietary component in avoiding obesity, heart disease and obesity at one percent of the diet. We have developed prototype salad dressings and potato chips as vehicles for human dietary CLA. We have also produced a 70% CLA-rich soy fraction by chromatographic separation which could be used as nutritional supplements.

#### Impact

The pilot plant system is a significant advance in producing CLA-rich soy oil and an important step in moving towards commercialization and providing consumers with the health benefits of increased CLA intake, without increasing total fat, saturated fat and cholesterol intake. Nutritional studies provide evidence that CLA-rich oil is effective against major diseases

affecting the U.S. population. The production and use of CLArich foods and evaluation of their effectiveness would have an important effect on human health. Two major food companies are very interested in this research and see the potential of CLA-rich foods in product development.

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#### Funding

U.S. Department of Agriculture National Research Initiative; Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture

## Pulmonary arterial hypertension: Avian model of complex vascular lesion development

#### Issue

Idiopathic pulmonary arterial hypertension (IPAH) is a disease of unknown cause that annually is diagnosed in two new human patients per million in the population, with a mean life expectancy of 2.8 years following diagnosis. IPAH is characterized by elevated pulmonary arterial pressure (PAP) and pulmonary vascular resistance (PVR) attributable to vasoconstriction and vascular remodeling of small pulmonary arterioles. Vascular remodeling includes hypertrophy and hyperplasia of smooth muscle within the tunica media (medial hypertrophy) accompanied in up to 80% of the cases by the formation of occlusive plexiform lesions in pulmonary arterioles. Patients tend to be unresponsive to vasodilator therapy and have an extremely poor prognosis for survival when plexogenic arteriopathy is present. Research is needed to understand and treat plexogenic arteriopathy, but advances have been hindered by the absence of spontaneously developing lesions in existing laboratory animal models. Chickens bred for meat production (broiler chickens, broilers) provide an excellent model of spontaneous IPAH triggered by increases in PVR. The development of IPAH in young broilers is accompanied by semi-occlusive endothelial proliferation that recapitulates the presumptive early stages of plexogenic arteriopathy and that potentially can progress into fully developed plexiform lesions, thereby providing biomedical researchers with a much-needed animal model of spontaneous plexogenic arteriopathy.

#### Action

Plexiform lesions develop in the pulmonary arteries of humans suffering from IPAH. Plexogenic arteriopathy rarely develops in existing animal models of IPAH. Our research demonstrated the development of plexiform lesions in the lungs of rapidly growing broiler chickens that had been genetically selected for susceptibility to IPAH. Plexiform lesions developed spontaneously in: 42% of females and 40% of males; 35% of right lungs and 45% of left lungs; and, at 8, 12, 16, 20, 24, and 52 weeks of age the plexiform lesion incidences averaged 52, 50, 51, 40, 36, and 22%, respectively. Plexiform lesions formed distal to branch points in muscular interparabronchial pulmonary arteries exhibiting intimal proliferation, at sites where turbulent blood flow and elevated shear stress are thought to initiate endothelial damage and create thrombogenic surfaces. Perivascular mononuclear cell infiltrates consistently surrounded the affected arteries. Proliferating intimal cells fully or partially occluded the arterial lumen adjacent to plexiform lesions. Broilers reared in clean stainless steel cages exhibited a 50% lesion incidence that did not differ from the 64% incidence in flock mates grown on dusty floor litter. Microparticles (30 µm diameter) were injected to determine if physical occlusion and focal inflammation within distal pulmonary arteries might initiate plexiform lesion development. Three months post-injection no plexiform lesions were observed in the vicinity of persisting microparticles. Broiler chickens selected for innate susceptibility to IPAH represent a new animal model for investigating the mechanisms responsible for spontaneous plexogenic arteriopathy.

#### Impact

We have introduced to the biomedical research community an experimental animal model (broiler chickens) that for the first time will permit direct experimental evaluation of the pathogenesis of spontaneous plexogenic arteriopathy.

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#### Funding

National Institutes of Health Grant "Pulmonary Arterial Hypertension: Avian Model of Complex Vascular Lesion Development"; University of Arkansas Division of Agriculture

# Education on biosecurity and disease recognition in poultry flocks

#### Issue

Mortality figures associated with broilers, turkeys, and layers are 4%, 8%, and 16% respectively over the life of the flock, with infectious diseases as a major cause of the mortality and responsible for an additional 1+% loss in condemnations. These losses have a serious impact on the economy of the state and amount to millions of dollars in lost product for human consumption, value of replacement stock, medication costs and in lost time associated with disease control. The discovery of avian influenza (AI) in Arkansas in 2008 actually did result in quarantine and related trade loss and costly control and testing efforts. The concern over AI and other diseases such as H1N1, LT, MG, and MS continues to be high. Continuing outbreaks of MG, MS, and LT have caused economic losses and costly control efforts. This year avian influenza was not in the news but H1N1 (swine flu) was. There was a tremendous concern that this disease (declared a pandemic by the World Health Organization) would cause serious illness mortality in people and tremendous associated economic losses. These concerns continue to drive the need for reinforcing educational efforts directed toward "biosecurity" to assist in preventing disease outbreaks and/or spread.

Animal agriculture production is a major contributor to gross domestic product and employment. The continued threat of bioterrorism is such that vigilance is needed to prevent the use of infectious disease as a weapon against the U.S. food supply.

#### Action

The University of Arkansas Division of Agriculture's poultry health extension veterinarian assists the poultry industry and producers and various private, backyard, and hobby flock owners with disease recognition so appropriate control and/or treatment protocols can be initiated in a timely manner.

He also serves as a member of the Arkansas Animal Disease Emergency Response team (AADER), Poultry Health Advisory committee (PHAC), and the extension biosecurity committee. These teams and committees are responsible for educating producers and individuals about disease prevention and biosecurity; assisting in preparing guidelines for the industry as related to disease outbreaks; and conducting seminars, "outbreak drills", and training sessions.

A timely diagnosis and treatment/control program is vital to containing a possible outbreak that could spread to numerous flocks. Continued dialogue with numerous backyard, hobby, and exhibition flock owners in Arkansas has assisted greatly with biosecurity efforts in small flocks and an increased awareness of disease and preventative measures that will enhance the efforts of the Arkansas poultry industry.

#### Impact

Education of individuals, farm and ranch owners, and producers on biosecurity practices and disease recognition helps prevent the accidental introduction and transmission of various diseases. The improvement in disease recognition by the poultry producer allows faster implementation of control procedures. In addition, the continued improvement of biosecurity protocols allows for better disease protection of a flock by reducing the exposure risk. Increased awareness of biosecurity and the continued threat of agroterrorism is one of our best weapons of defense. This vigilance and implementation of biosecurity protocols further enhances the efforts to prevent diseases such as "bird flu," which are of great concern because of the potential adverse human health problems associated with the disease.

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#### Funding

Hatch/Animal Health Funds, Arkansas poultry industry University of Arkansas Division of Agriculture

# Reducing *Listeria monocytogenes* contamination of ready-to-eat deli meats

#### Issue

Reducing *Listeria monocytogenes* (LM) contamination of Ready-To-Eat (RTE) deli meats may be the most pressing food safety issue facing consumers, FSIS and the industry. Deli sliced meats are the single highest risk for listeriosis among 23 categories of RTE foods. FDA and FSIS risk assessors estimate that nearly 1600 new cases of listeriosis occur with a fatality rate approaching 20% in vulnerable populations. Previous research has shown that there is up to eight times higher incidence of LM contamination of RTE deli meat sliced fresh in a retail deli as compared to deli meat sliced and packaged by a food processor under continuous FSIS inspection. On the other hand, retail delis are not inspected by any federal agency and have a mixture of municipal, county and state health department regulations and inspections.

#### Action

Significant advances have been made by the meat and poultry industries to minimize contamination of (RTE) sliced deli meats using improved sanitation and antimicrobials that suppress the outgrowth of low levels of *Listeria monocytogenes* (Lm). The next step is research focused on more effective cleaning and sanitizing of the deli equipment and environment to further reduce the risk of listeriosis.

We are in the second phase of research sponsored by the American Meat Foundation, which has found that two approved red food dyes, FD&C No. 3 and No. 40 vividly stain the protein and fat residues missed during cleaning. In tests of 4 sanitizers used by retail delis against *Listeria* biofilms on aluminum or stainless steel components, the best results were obtained with the commercial cleaner J512. Additional research has shown that holding deli slicer food contact components in dry oven conditions at 66, 77 or 82 °C, for extended times up to 15 h was not effective for eliminating *Listeria* on the slicer component surfaces. However, heating the components in moist oven conditions caused the desired 5 log reduction of *Listeria* within 3 h at 82 °C.

#### Impact

We have demonstrated that there is an easy, inexpensive method to determine slicer cleanliness prior to sanitation. We have also elucidated which of the sanitizers currently in use are the most effective. We have demonstrated the usefulness of "hot box" technology for the sanitation of deli meat slicers. We have completed this initial phase with support from AMI and the industry.

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#### Funding

American Meat Foundation; University of Arkansas Division of Agriculture

# Use of natural feed additives to reduce *Campylobacter* colonization in poultry

#### Issue

Campylobacter is the one of the most commonly reported bacterial causes of human food borne infections in the United States with an estimated 2.1 to 2.4 million cases reported annually. Epidemiological evidence indicates that a significant proportion of human infections result from the improper preparation of poultry products. The cost of poultry-associated cases of campylobacteriosis in the U.S. is estimated at \$360 to almost \$700 million annually. Numerous studies have shown that a substantial number of retail chicken and turkey products are contaminated with Campylobacter. Despite commendable progress achieved in food safety through pathogen reduction programs the commensal relationship between Campylobacter and poultry makes control measures against them difficult. Therefore, innovative on-farm strategies for preventing colonization of birds are critical to prevent the contamination of poultry products with these pathogens.

#### Action

Our laboratory is at the forefront of investigating preharvest strategies to reduce *Campylobacter* contamination in poultry. One of our major focuses is evaluating and developing strategies utilizing natural antimicrobial compounds. We have been successful with numerous compounds including demonstrating the efficacy of bacteriocins (proteins naturally produced by bacteria that kill or inhibit the growth of other bacteria). Recently we have explored the effectiveness of caprylic acid, a natural fatty acid present in breast milk and coconut oil, which is a food-grade chemical approved by the FDA as Generally Recognized As Safe (GRAS). Our research has demonstrated that caprylic acid can kill a variety of pathogenic bacteria. We conducted a series of studies to evaluate the ability of caprylic acid to reduce *Campylobacter* population in chickens. We found consistent reductions in *Campylobacter* colonization. The therapeutic results are particularly significant because there are few successful strategies to reduce *Campylobacter* in the live bird once they are contaminated.

#### Impact

The results demonstrate both therapeutic and prophylactic supplementation of caprylic acid in the feed can effectively reduce *Campylobacter* in poultry and may be a potential treatment for reducing pathogen carriage in poultry. Use of these natural compounds may provide an important tool to provide a safer food supply to consumers.

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#### Funding

USDA- NIFSI USDA- AFRI University of Arkansas Division of Agriculture

# Development of novel bacterial vectored vaccines against avian influenza

#### Issue

Avian influenza (AI) is a significant public health concern and a serious economic threat to the commercial poultry industry worldwide. In the last five years, there has been a substantial increase in the number of AI outbreaks in poultry flocks, and the number of birds affected in AI outbreaks has increased 100-fold, mostly in Asia. Current influenza vaccines target antibody production against the surface glycoproteins, hemagglutinin (HA) and neuraminidase. However, these antigenic molecules are highly susceptible to recombination (shift) and mutations (drift). This results in the need to frequently update the vaccine to protect against currently circulating strains. Therefore, there is a critical need for new influenza vaccines, which are able to provide protective immunity against current and future AI virus strains.

#### Action

Candidate bacterial vectored vaccine strains were developed which express a conserved outer membrane protein sequence from avian influenza on the bacterial cell surface. Due to the potential of the bacterial vector to cause infection, two virulence genes were deleted for attenuation purposes. The candidate vaccine strains were then used in experimental studies to determine serum antibody titers to the presented polypeptide, persistence of the vector within the host and ability of the candidate vaccine to protect against direct high and low pathogencity avian influenza challenge. In initial evaluations,

the candidate vaccine demonstrates significant promise. This is especially true for those isolates that threaten the United States poultry industry each year. During 2009, new molecule insertions for enhancing immune response were evaluated with highly promising results for oral administration, even with a Generally Recognized As Safe (GRAS) vector that we have developed. Challenge testing of vaccinated poultry is anticipated in 2010.

#### Impact

Increasing the resistance of the poultry population against AI will not only prevent substantial economic losses to the poultry industry due to the high morbidity and mortality associated with AI in poultry flocks, but will also reduce the significant health risk for the human population as well. As certain avian influenza outbreaks could immediately close State borders to poultry export, a marked effect on the entire State economy could be felt. If commercialized and used, this vaccine approach could reduce the likelihood of infection within Arkansas or could reduce transmission during cleanup after an outbreak.

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#### Funding

University of Arkansas Division of Agriculture

# Development of a novel bacterial vectored vaccine against *Salmonella*

#### Issue

Salmonella continues to be one of the most commonly reported bacterial causes of human food-borne infections worldwide, and epidemiological evidence indicates that poultry and poultry products are a significant source of human infection. In contrast to humans, Salmonella infrequently causes apparent clinical disease in poultry flocks. However, infection in young chicks with some Salmonella isolates results in 2% mortality within the first 48 hours post-hatch, and up to 20% morbidity within the first five days. Researchers have previously demonstrated that poultry flocks that are not infected with Salmonella prior to slaughter will not become contaminated unless processed after positive flocks. Therefore, preharvest intervention through the use of effective vaccination programs that can effectively protect poultry against multiple serovars is one important strategy for reducing the contamination of poultry products with this food-borne pathogen. An important part of the problem is that there are several dozen Salmonella serovars that commonly infect commercial poultry. As traditional vaccines only protect against a single (or very limited number) of Salmonella serovars, this has greatly limited the effective use of vaccines under commercial conditions.

#### Action

With specific competitive USDA NRI funding for this project, candidate bacterial vectored vaccine strains were

developed that express a conserved flagellar antigen sequence from *Salmonella* on the bacterial cell surface. This antigen shares extensive homology with many Salmonella serovars as well as *Shighella* and *E. Coli*. Due to the bacteria's potential to cause infection, two virulence genes were deleted for attenuation purposes. The candidate vaccine strains were then used in experimental studies to determine serum antibody titers to the cell surface expressed antigen and persistence of the vector within the host. Early results indicate that vaccinated birds clear the systemic infection very quickly after even very high challenge levels with wild-type *Salmonella* isolates.

#### Impact

Increasing the resistance of the poultry population against *Salmonella* will not only reduce the impact of low level disease on performance associated with *Salmonella* in poultry productions, but will also significantly reduce the potential of poultry products contributing to human food-borne illnesses within the human population. In the United States, it is estimated that 1.4 million humans contract salmonellosis each year, and that the annual cost of this illness, including lost productivity, is \$3 billion (WHO, 2006).

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#### Funding

University of Arkansas Division of Agriculture

## Electrostatic spray treatments with organic acids and plant extracts enhance decontamination of *Salmonella* Typhimurium and *Escherichia coli* O157:H7 in spinach

#### Issue

Foodborne illnesses are a substantial health burden in the United States. According to the CDC, Salmonella sickens about 40,000 people a year in the US and kills about 600 (CDC 2009). Salmonella Typhimurium was the most commonly isolated serotype causing 16.9% of all human salmonellosis illnesses, and ranks at the top of Salmonella isolates from human and non-human sources. Escherichia coli O157:H7 causes 73,000 infections annually and 52% of those outbreaks have been found to be food borne in origin (CDC 2009, Rangel et al. 2005). These food pathogens have been linked to several outbreaks in the past few years. Fresh and fresh cut fruits and vegetables often eaten without prior processing are potential sources of S. Typhimurium and E. coli O157:H7 infections. Salmonella and E.coli O157:H7 contaminated on the surface are embedded in biofilms or attached as aggregates and are resistant to environmental stress and disinfectants. The conventional methods for reducing pathogens on fresh produce involve washing them with water or chemicals like chlorine, peracetic acid, hydrogen peroxide, mechanical treatment of the surface by brush and spray washers or use of chemical preservatives. However, some of these food preservation systems can have undesirable effects. This has led to investigating the efficacy of natural antimicrobial substances that will not only serve as a safe alternative for chemicals in maintaining the microbiological safety, but also provide fresher, additivefree and more natural sensory attributes as food preservatives. Novel systems need to be explored to apply the antimicrobials to fresh produce as conventional spraying can have limitations of uneven distribution, and surface run off.

#### Action

Organic acids and salts are promising antimicrobial agents because of their acceptance in food products and low cost. Many natural plant extracts have also been screened for antimicrobial properties and some of these include coriander, eucalyptus, cilantro and mustard oils, Gingko extracts, grape seed extracts and green tea extracts. In our laboratory, organic acids such as malic and tartaric acids and grape seed extracts have been extensively studied to show bactericidal activities and can be incorporated into edible films for produce and meat. We investigated the optimum concentrations of combinations of organic acids (malic, tartaric and lactic acids) and grape seed extract on inhibiting S. Typhimurium and E.coli O157:H7 in spinach using a response surface method. The method of application being equally important, the efficacies of electrostatic and conventional spraying were compared by administering the antimicrobial solutions by both procedures. Malic acid (3%) and lactic acid (3%), and malic acid (2%) and GSE (3%) combinations were demonstrated to inhibit S. Typhimurium on spinach by 4.3 log CFU/ml and 3.3 log CFU/ml respectively when sprayed electrostatically. Malic and lactic acids (3% each) combined and applied by electrostatic spraying inhibited E. coli O157:H7 by 2.9-3.4 log CFU/g.

#### Impact

The microbial safety of fresh produce is often challenged by the sporadic incidences of outbreaks. As washing and rinsing do not completely decontaminate fresh produce, which is consumed as such, microbial safety must be ensured at the selling point of produce. Malic acid in combination with grape seed extract or lactic acid solutions applied by electrostatic spraying can be used for commercial applications to enhance food safety. The combination of these natural antimicrobial products applied by electrostatic spraying can serve as an effective multiple hurdle technology to disrupt the biofilms formed by the food borne pathogens and decontaminate the produce surfaces. This research can lead to the development of an intervention strategy at the post harvest level using multiple hurdle technology for the long term improvement of food safety and quality of fresh produce.

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#### Funding

NRI; University of Arkansas Division of Agriculture

# Antimicrobial levels affect *Listeria* contamination in food products

#### Issue

In the U.S., 76 million cases of food borne diseases with 325,000 hospitalizations and 5,000 deaths occur each year. Outbreaks of food borne pathogens including *Listeria mono-cytogenes* (*L.m*), *E. coli* O157:H7 (E.c) and *Salmonella* Typh-imurium (*S.T*) contaminated ready-to-eat (RTE) poultry and meat products are of great concern to the food industry and the general public. Among the RTE foods, deli meats and hotdogs posed the highest per serving risk of illness/death. Lactates and diacetate antimicrobials were found to be bacteriostatic than bactericidal in activity, and therefore may not be effective against gross contamination of a product. Higher concentrations of antimicrobials used in the formulation may affect the sensory qualities of the product, such as flavor and texture, while lower concentrations may not provide enhanced safety to the product.

#### Action

A study to determine the optimum concentration level of potassium lactate and sodium diacetate in combination within permissible levels in RTE high and low fat chicken and turkey hotdogs was conducted. In this study, high (20%) and low (6%) fat chicken and turkey hotdogs were formulated with combination of varying concentration levels of potassium lacatate (PL; 0, 2, 2.5, and 3%) and sodium diacetate (SDA; 0, 0.1, 0.15 and 2%) within the permissible levels. All the treatments (hotdog slices; 1cm<sup>3</sup>, 1-1.5 g) were surface inoculated with Listeria monocytogenes bacterial suspension (10<sup>4</sup> cfu/g), packed with or without vacuum conditions and stored at 4 °C and 8 °C over 42 days. Maximum log reduction (1.06 log cfu/g) was observed in chicken low fat and turkey high fat (20%) hot dogs having 3% potassium lactate and 0.1% sodium diacetate which was stored at 4 °C under vacuum pack conditions, while the maximum log reductions obtained in commercial hotdogs formulated with 2% potassium lactate was 0.56 log cfu/g.

#### Impact

Current usage levels of potassium lactate and diacetates ( $\leq 2\%$ ) in combination may not provide effective inhibition (0.56 log cfu/g) of *Listeria* when the product gets contaminated. Therefore, other hurdle technologies (natural plant extracts that have antimicrobial properties) in addition to using optimum levels of chemical antimicrobials need investigation to obtain minimum detectable levels of these pathogens.

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#### Funding

University of Arkansas Division of Agriculture; Food Safety Consortium

## Nanoparticle delivery of natural antimicrobials can enhance effectiveness

#### Issue

The prevention of food borne diseases is chiefly dependent on the precautions taken during production, processing, handling, and storage. Strategies for inhibition of these pathogens are of great concern for both food industries and the consumers. Interest has increased in natural ingredients as an alternative to chemicals and disinfectants to sanitize food products. To preserve the maximum potential of such antimicrobials, an efficient mode of delivering these compounds to foods is also essential. This process would ensure their controlled release, activity, an enhanced microbial inhibition, proper distribution and minimal interaction with food components.

#### Action

Several antimicrobial extracts from plants have been researched in our laboratory. Polyphenolics constitute a large group of secondary plant metabolites present in natural plant extracts that are mainly responsible for the plant's defense mechanisms against microbial agents. Owing to the potential antimicrobial properties of polyphenolics and their GRAS (Generally Regarded as Safe) nature, they can serve to control pathogens in food systems. Different systems to deliver the potential antimicrobials to food systems have been explored to enhance inhibition and sustain their activities for a longer period of time. The minimum inhibitory concentrations (MIC) of polyphenolic compounds alone and in combinations against Listeria monocytogenes, S. Typhimurium and E. coli O157:H7 were evaluated. These polyphenolic compounds were packaged into poly lactic glycolic acid nanoparticles and tested for their antimicrobial activites. The packaging of polyphenolics in nanoparticles improved the inhibition of pathogens to 6.0-6.5 log CFU/ml at a much lower concentration (1100 µg/ ml) than when used individually (5000 µg/ml). Nanoparticles prevent the undesired interactions of polyphenolics with BHI medium or food components that can increase the amount of individual polyphenolic needed, enhance distribution and potency of every packaged polyphenolic molecule and ensure a sustained release over a longer period of time.

#### Impact

The use of nanoparticles as vehicles for delivering antimicrobial compounds could revolutionize food safety practices. The therapeutic properties of all safe natural plant products is of tremendous interest in food industries due to their health benefits to consumers, enrichment of foods, antimicrobial properties thus helping to extend the freshness, shelf life and safety of ready to eat poultry and meat products. Nanoparticlemediated delivery can enhance inhibition (≈2 log reduction higher) of food-borne pathogens at lower polyphenolic acid concentrations (≈78% lower). Polyphenolics can be used as natural and safe substitutes to chemical disinfectants in food systems to better control pathogens. This research will serve as a multiple hurdle technology with the application of nanotechnology and antimicrobials as control measures for bacteria from poultry products. This could considerably reduce the economic loss associated with food borne illnesses in the U.S.

and promote a more natural and potent alternative to the use of chemicals as antimicrobials in food systems.

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#### Funding

University of Arkansas Division of Agriculture; Food Safety Consortium

# Portable impedance biosensor for in-field detection of avian influenza H5N1

#### Issue

Avian influenza (AI) virus H5N1 was discovered in the late 1990s, and it has been reported by the World Health Organization to be in more than 46 countries for animal cases and in 15 countries for human cases with 467 people infected and 282 died since 2003. In the U.S., a recent outbreak of low pathogenic AI in 2001 and 2002 resulted in the depopulation of over 4.5 million chickens and turkeys and had cost the poultry industry approximately \$125 million. World Bank estimated that more than 140 million birds had died or been destroyed due to AI H5N1 and losses to the poultry industry are in excess of \$10 billion worldwide. A key in controlling the spread of AI is to rapidly detect the disease, and then eradicate infected animals, quarantine and vaccinate animals. The technology for detection of AI H5N1 is mature, but many tests are complex, some are liable to error, and some can be performed safely only in BSL3 facilities. A simple, rapid, robust and reliable AI test, suitable for use in the field, is urgently needed.

#### Action

A portable biosensor has been developed for in-field sensitive and specific detection of AI virus H5N1 in poultry swab samples. Magnetic nanobeads are coated with specific antibodies to target virus and used in the sampler to separate and concentrate target virus from a poultry swab sample. Red blood cells, as biolabels, are mixed with the captured target virus to form the bio-nanobead-virus-red blood cell complex. A microfluidic biochip is designed and fabricated as a flowthrough device to deliver the complex to an embedded interdigitated array microelectrode for impedance measurement. The change in impedance of the bionanobead-virus-red blood cell complex is correlated to the concentration of AI virus H5N1 in the original swab sample. Our results showed that a positive signal was clearly obtained when the concentration of AI virus H5N1 in cloacal swabs was equal to or more than 100 EID<sub>50</sub>/mL. At 10 kHz frequency, the impedance of AI virus H5N1 significantly increased compared to either no any viruses or only Newcastle and Infectious Bronchitis viruses. The test on live H5N2 virus in infected chickens indicated the biosensor presented the same results as that by RT-PCR. A U.S. patent has been filed. A research prototype of this biosensor has been designed and fabricated and is being evaluated with viable AI H5N1 in a BSL-3 lab and field tests.

#### Impact

Since currently there is no in-field AI test instrument avail-

able, this biosensor would provide the poultry industry with a very needed technology for rapid, sensitive and specific screening of AI H5N1 in poultry. This will help the poultry industry be better prepared for AI H5N1, ensure poultry product safety and security, and minimize the testing cost. Further, this will help our society in surveillance and control of avian influenza infections with animal and human.

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#### Funding

USDA/NRI, Arkansas Biosciences Institute, University of Arkansas Division of Agriculture

## Magnetic nanoparticle microfluidics for high efficient capture, separation and concentration of foodborne pathogens

#### Issue

Contaminated food, mainly by pathogenic microorganisms, is estimated to cause 76 million illnesses, 325,000 serious illnesses resulting in hospitalization, and 5,000 deaths in the U.S. each year. USDA/ERS estimates the medical costs and productivity losses associated with *E. coli* O157, *Salmonella*, *Listeria monocytogenes* and *Campylobacter* alone amount to at least \$6.9 billion annually. Current methods for detection of bacteria rely upon culture plating, ELISA and PCR. However, these methods are time consuming, expensive, or not specific, and require trained operators with laboratory facilities. There is an urgent need for rapid method in detection of major foodborne pathogens. At the same time, food sample preparation is critical to ensure the specificity and sensitivity of a rapid detection method for foodborne pathogens.

#### Action

The objective of this project is to develop a magnetic nanoparticle-based sample preparation method for rapid capture, separation and concentration of target pathogenic bacteria in foods. A single channel magnetic microfluidic device was designed and fabricated, and it demonstrated the rapid and high efficient separation of the food and water borne pathogens, including *E. coli* O157:H7, *S.* Typhimurium, and *L. monocytogenes.* The key tasks were accomplished: (1) Theoretical estimation of forces exerted on the magnetic nanoparticles in a fluidic solution under the magnetic field, and simulation of movement track of magnetic nanoparticles in a fluidic system under the magnetic field and the corresponding magnetic gradient; (2) Design and fabricate a continuous fluidic mag-

netic separation device based on theoretical consideration and simulation results, a high magnetic field gradient was created by introducing a stainless steel rod situated tightly on one side of separation channel; (3) Proof of the concept that bacterial cells bound with a few magnetic nanoparticles (MNPs) through non-specific binding can be separated and removed from the target cells bound with a large number of MNPs, in contrast, the non-specific bacterial cells bound with a few magnetic microbeads cannot be separated and removed from the sample; and (4) Separation of magnetic nanoparticle-labeled target pathogen from a mixture of magnetic and non-magnetic pathogens using the fabricated fluidic device. The target pathogens with the concentration of  $\sim 10^3$  CFU/mL can be isolated and collected from a mixture solution containing the same concentration of competing bacterium using 30 nm MNPs and the fluidic device. There is 83.6% of target magnetic cells has been isolated and collected from bulk solution considering the number of magnetic cells flowed from upside outlet and the flushed ones, and 81.6% of competing bacterium flowed out from waster outlet and removed from the mixture.

#### Impact

The results of this project could provide the food industry with new technology to prepare the food sample for rapid detection of foodborne pathogens. Food samples from poultry, meat, dairy, vegetables and fruits can be treated effectively to capture, separate, and concentrate the target pathogens in less than 30 min. The food industry could save millions of dollars annually by avoiding product recalls since this effective sample preparation method in couple with any rapid detection method could reduce the microbial detection time from more than 8-24 hours down to 1-2 hours. Consumers could benefit from reduced foodborne sickness and associated medical costs. This technology will also help our society reduce foodborne diseases and strengthen the safety and security of our food supply system.

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NSF/STTR; University of Arkansas Division of Agriculture

# Aptamers for rapid detection of avian influenza virus

#### Issue

Avian influenza (AI) virus H5N1 was discovered in the late 1990s, and it has been reported by the World Health Organization to be in more than 46 countries for animal cases and in 15 countries for human cases with 467 people infected and 282 died since 2003. In the U.S., a recent outbreak of low pathogenic AI in 2001 and 2002 resulted in the depopulation of over 4.5 million chickens and turkeys and had cost the poultry industry approximately \$125 million. World Bank estimated

that more than 140 million birds had died or been destroyed due to AI H5N1 and losses to the poultry industry are in excess of \$10 billion worldwide. A key in controlling the spread of AI is to rapidly detect the disease, and then eradicate infected animals, quarantine and vaccinate animals. The technology for detection of AI H5N1 is mature, but many tests are complex, some are liable to error, and some can be performed safely only in BSL3 facilities. A simple, rapid, robust and reliable AI test, suitable for use in the field, is urgently needed.

#### Action

Aptamers are oligonucleic acid or peptide molecules that bind a specific target molecule. They show higher affinity for target virus and better thermal stability than antibodies. Those advantages make aptamers promising candidates in diagnostic applications. The objectives of this project were to: (1) select ssDNA and aptamer to specifically bind avian influenza H5N1 virus using systematic evolution of ligands by exponential enrichment (SELEX) method, and the affinity and specificity of the aptamer were evaluated and compared with polyclonal and monoclonal antibodies against AI H5N1; and (2) apply the selected aptamers to the detection of AI subtype H5N1 at low concentrations in swab poultry samples using a biosensor method such as SPR, impedance or magnetoelastic biosensor. H5N1-bound DNA aptamers were selected by incubating H5N1 virus with a DNA library of about 1014 molecules randomized at central 74 nt and subsequent nitrocellulose filtration. Aptamers were eluted from filters and amplified by PCR. Single-stranded aptamer DNAs were derived from this doublestranded DNA stock by asymmetric PCR as input for the next selection cycle. Individual aptamer DNAs was cloned and sequenced from single-stranded DNAs pool of final selection cycle. Dot ELISA and Dot Blot were applied to determine the affinity of selected aptamers. After 14 cycles of isolation, 115 bp DNA-aptamers which bound to H5N1 were first screened out and 3 apatmer sequences were obtained after cloning. Results showed that those selected DNA-aptamers have better specificity and stronger binding affinity to AI subtype H5N1 than monoclonal antibodies.

#### Impact

Since the applications of immunosensors for in-field screening of avian influenza virus are limited by the use of temperature sensitive antibodies, this aptamer sensing material would provide a better option to the biosensor technology as well as diagnostic kits for in-field rapid, sensitive and specific screening of avian influenza H5N1 in poultry swab samples. This will help the poultry industry more effectively monitoring avian influenza H5N1, different subtypes and other poultry diseases with lower testing cost.

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# Antimicrobial edible coatings to improve beef steak's microbial quality

#### Issue

Microbial safety continues to be an important issue in the beef industry. The beef producers are intensifying their efforts to minimize the presence of pathogenic bacteria in beef products through application of different decontamination techniques. However, most decontamination treatments can cause deleterious changes in the product quality. Hence, there is a vital need to find decontamination techniques that would not only bestow consumer's meat safety expectations but also quality characteristics preferences.

#### Action

The use of edible coatings is a new emerging technique that can be used to improve microbial safety and shelf life of food products. In-cooperation of antimicrobials in an edible coating system further enhances the safety and quality measures. Since meat decontamination primarily takes place on the surface, slow migration of antimicrobial agent from the edible coating may provide higher concentration of active ingredient where it is needed. Previous studies have shown that use of USDA approved potassium lactate (KL) and trisodium phosphate (TSP) in meat decontamination has improved microbial safety without causing deleterious effects on meat color. Inoculated steaks from biceps femoris (n = 75; *Escherichia coli* (EC) and Salmonella typhimurium (ST) (107 CFU/g) were dipped in Gelatin with 0, 1.5 or 3 % KL or 0, 5 or 10% TSP solutions (n = 5/treatment) for 1 min. Then the treated and untreated inoculated control steaks (CON) were packaged and displayed under simulated retail conditions and sampled on day 0, 1, 2, 3 and 7 for EC, ST, coliform (CO) and aerobic plate count (APC).

#### Impact

The ability of gelatin coating with or without potassium lactate or trisodium phosphate to reduce bacterial counts on inoculated steaks indicates that a gelatin coating system may provide a new process control measure as a smart antimicrobial edible coating system to decontaminate meat products. Incorporation of these antimicrobial agents in the gelatin coating system will enhance the decontamination and may improve the product safety and shelf life for an extended period.

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#### Funding

Arkansas Beef Council, University of Arkansas Division of Agriculture

## Impact of antimicrobial decontamination at subprimal level on beef quality characteristics

#### Issue

A number of large safety recalls related to *E. coli* O157:H7 have highlights the need for additional decontamination measures to ensure meat safety. Therefore, there is an urgent need for U.S. beef processors to implement decontamination technologies at primal/subprimal processing levels to eliminate the incidents of pathogenic bacteria in the final product.

#### Action

Biceps femoris subsections (n = 75) were brushed inoculated with *Escherichia coli* (EC) and *Salmonella* typhimurium (ST) (10<sup>7</sup> CFU/g. Each subsection was spray treated with either: (1) water; (2) 3% potassium lactate (KL); (3) 4% so-dium metasilicate (NMS); (4) 0.5% cetylpyridunium chloride (CPC); or (5) 10% trisodium phosphate (TSP). Un-inoculated untreated (CON) and inoculated untreated samples were run parallel as controls. Following spray treatments, each subsection was cut into three individual steaks (n = 105) and were placed on foam trays with absorbent pads, overwrapped with polyvinyl chloride film, and displayed under stimulated retail conditions. Treated and untreated samples were evaluated for EC, ST, coliforms (CO), and aerobic plate count (APC) and Instrumental color characteristics on day 0, 1, 2, 3, 5, and 7.

#### Impact

The results indicated that KL, NMS, TSP, CPC and water spray application of inoculated subprimals may improve the microbial quality on day 1. However to improve microbial qualities to a greater extent of time, further decontamination treatment will be required. Therefore, a secondary spray application of antimicrobial treatments at steak level is recommended.

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# Foodborne *Salmonella* Typhimurium survival and virulence expression during food processing

#### Issue

Salmonellosis is one of the most common foodborne diseases in the United States. Given that *Salmonella* can originate from a wide variety of food production environments, reduction of this organism at all stages of food production is critical. This project has three components designed to address this problem. Our specific research program goal reflects an integrated approach for controlling *Salmonella* spp. and other foodborne pathogens at all stages of food production. The relative incidence of *Salmonella* spp. foodborne disease continues, despite the growing body of information regarding the most common contamination routes. During its life cycle, *Salmonella enterica* serotype Typhimurium can encounter various environmental stress conditions which may have dramatic effect(s) on its survival and virulence. Although there is considerable information regarding environmental signals that control growth and pathogenesis in animals and humans, little is known about the biology of *Salmonella* during food processing. Research is needed to determine the environmental factors that are critical for survival of this pathogen and therefore must be modified to prevent the early establishment of Salmonella in food processing environments and virulence expression under these conditions.

#### Action

Our current food production Salmonella spp. research projects have emphasized studies on the growth, survival and pathogenesis of the organism under conditions encountered during poultry processing. However, the success of Salmonella spp. in becoming re-established in the gastrointestinal tract of food animals during certain phases of processing indicates that Salmonella spp. can competitively interact with the dynamics of the food matrix. Based on these observations, our plan is to continue to focus on salmonellae metabolism and genetic regulation of stress responses when grown under processing conditions and determine how these overlap with expression of virulence when foodborne Salmonella spp. become pathogenic. The outcome of this research has implications not only for persistence of foodborne salmonellae in processing, but raises practical issues regarding the choices of antimicrobials as intervention steps in processing. Issues we are now pursuing include whether thermal treatment predisposes salmonellae to be more resistant to particular antimicrobials and how these conditions might influence virulence and pathogenic characteristics of salmonellae. Molecular techniques will delineate some of the phenotypic responses we have observed thus far and examine virulence expression of Salmonella under typical food production and processing conditions.

#### Impact

Illness from *Salmonella* contaminated poultry is a huge problem. Despite the best efforts of the conventional poultry industry, the levels of *Salmonella* contamination are increasing. One of the objectives of the Healthy People 2010 Initiative (2000) established a goal of no more than 6.8 cases of salmonellosis/100,000 persons, which is half of the baseline rate of 13.6/100,000. Unfortunately, in 2006, a rate of 14.8 cases/100,000 was reported, which was higher even than the baseline rate. Thus, *Salmonella*-mediated foodborne illness continues to be a serious problem. There are many potential foodborne vehicles, but contaminated poultry meat has been implicated as a major contributor to salmonellosis both in the U.S. and in Europe.

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#### Funding

USDA Food Safety Consortium, USDA Postdoctoral Fellowship; University of Arkansas Division of Agriculture

# An integrated systems approach to reduce *Salmonella* in organic and 'natural' poultry

#### Issue

Consumers purchase organic meats for superior taste, better nutritional value, long-term health benefits, enhanced product freshness and curiosity about the differences between organic and non-organic meats. Many consumers also believe organic poultry is safer than conventional. However, reports comparing conventional to organic poultry have demonstrated that organic poultry may have a higher rate of Salmonella contamination. Organic poultry products may have higher contamination rates of Salmonella because the use of antimicrobials is restricted in both live production and at the plant. This is also true for "natural" poultry production where antibiotics are not used. In addition, organic and all-natural poultry are characterized by production and processing in smaller facilities. Birds are processed in small, independent facilities in states that permit small-scale exemptions to federal inspection. Small production is usually not integrated, providing less opportunity for control of product quality, including food safety, as in large-scale, integrated production. In 2006, USDA/FSIS reported the percentage of positives for Salmonella in conventionally grown broilers was highly correlated to the size of the slaughter facility. The prevalence rates for 2005, were 14.7, 18.6 and 32.9% for large, small and very small establishments, respectively. Results for similar organic facilities are not known. Therefore, it is absolutely essential to further USDA's goals of reducing Salmonella contamination by developing an integrated approach for natural and organic poultry in both the preharvest and postharvest areas, to fill in critical gaps in determining Salmonella contamination and to develop effective measures to minimize it. Key food safety and Salmonella control points in preharvest must be identified and intervention strategies developed. However, almost no university research has focused on small-scale poultry production systems or their food safety issues.

#### Action

We are comparing natural live production and processing systems and conveying these findings in a series of implementation steps by: 1) Monitoring foodborne pathogen appearance during production and processing 2) Characterizing strains and serotypes of foodborne pathogen isolates. We are collecting environmental samples for both cultural and molecular analysis. These results and the corresponding profiles will provide us with a better idea where foodborne pathogens are occurring and what factors contribute to ther prevalence

#### Impact

*Salmonella* contaminated raw poultry is a vexing problem for regulators, USDA and FSIS, as well as consumers. This problem could grow much worse with the rapid rise in consumer demand for all-natural and organic poultry. Marketing research reports indicate that one of the "drivers"

for consumers to purchase organic foods is personal or close family experience with a debilitating medical condition. Immediate action is required to protect these immunocompromised consumers of organic poultry. Salmonella contaminated organic and natural poultry products impacts not only this segment of the population but will, as markets grow, negatively impact an increasing number of consumers and consequently a wider spectrum of the poultry industry. By 2005, organic fresh poultry, meat and seafood sales were the fastest growing segment (67.4%) of the organic foods market that grew at an overall 15.7% increase in sales. In 2005, sales of organic poultry, meats and seafood reached \$114 million. Organic poultry is the largest share of the organic meat market. A 16,000% increase in USDA Organic broilers from 1997 (38,285 broilers) to 2003 (6.3 million broilers) has been reported. This number will climb to 60 million Certified Organic broilers by 2011. Currently, organic poultry only constitutes 1-2% of the total poultry market, but it is one of the fastest growing sectors in the food market. Chicken leads as an organic meat due to its short production cycle, which allows suppliers to quickly increase supply. Lower costs of production relative to other meats also mean that organic chicken is only about 20% higher priced than conventional, compared to 30-40% price premiums for other organic meats. The trend is expected to continue with annual growth of organic poultry estimated at 33% through 2008. This is supported by the fact that Pilgrim's Pride and Tyson Foods who together produce about 2/3 of U.S. conventionally raised poultry and both have natural poultry product lines. Tyson Foods converted all of its fresh chicken in 2007 to "raised without antibiotics."

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National Integrated Food safety Initiative, USDA Food Safety Consortium; University of Arkansas Division of Agriculture

# Stress increases pathogen's ability to survive further stress

*Campylobacter jejuni* is the leading cause of foodborne bacterial diarrhea in the United States. There are approximately 2.4 million cases of campylobacteriosis each year. Because many cases are not reported, the actual number of cases per year is thought to be underestimated by 5 or even 10 times. The medical costs and loss of productivity associated with this disease is estimated to be 1.2 billion dollars annually. *C. jejuni* colonizes the gut of the chicken without causing disease or adverse affects on the health of the animals. Raw poultry products are considered to be a major source of *C. jejuni* infections in humans. Therefore, control of environmental sources of *C. jejuni* that can potentially infect chickens is crucial. An understanding of how this fastidious bacterium survives outside a host also can provide valuable information to design intervention strategies. Finally, detection strategies are necessary to ensure the safety of poultry products and provide information to risk assessors.

#### Action

*C. jejuni* is susceptible to a variety of environmental conditions that make it unlikely to survive for long period of time outside the host. Yet this organism is capable of surviving adverse conditions and causes disease in humans. Studies were done to investigate the effect of revival after exposure to stress

on the survival of *C. jejuni* cells when exposed to further stress. *C. jejuni* strains were exposed to acid conditions, allowed to recover and again challenged with acid as against cells exposed to acid conditions and again challenged with acid immediately after the first exposure with no recovery period in between. Revival of cells after exposure to stress did not have any effect on the viability and survival of cells when exposed to further stress. But in both cases viability and survival was found to be greater in acid-adapted *C.jejuni* but varied with strains and time.

Adhesion and invasion are thought to be important factors for the colonization of *C. jejuni* in the intestinal tract of host. We investigated the adhesion and invasion abilities of the organism after stress adaptation to stresses such as acid and starvation. The results indicate that *C. jejuni* surviving stress can increase chances of surviving further stress such as passage through the human gastrointestinal tract and stress may be a significant factor in inducing some virulence genes such as cadF required for colonization of the organism. Work is in progress to determine other virulence genes and genes involved in stress adaptation as well to identify the proteins that they encode.

#### Impact

Reducing *C. jejuni* in the environment and improving detection methods can decrease the prevalence of campylobacteriosis, benefiting both producers and consumers. Since 1970, the consumption of chicken has more than doubled. Because innovations in breeding, mass production, contract farming, vertical integration, and marketing have made chicken more plentiful and affordable, the price of chicken has also decreased. Poultry and poultry products are the most affordable source protein to many Americans. In order to keep these products safe for consumers, continuing research is needed to reduce *C. jejuni* in the environment and prevent cross-contamination.

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USDA/CREES; University of Arkansas Division of Agriculture

# Greater Harmony Between Agriculture and the Environment

# Application of cotton gin waste and recycled cotton bale wrap in lignocellulosic composites (LCC)

#### Issue

Two of the major waste streams of cotton cultivation include the gin waste that comes from cotton gins, and the plastic film used for wrapping the cotton bales in the new John Deere cotton module builder. Both of these waste streams do not have any significant application at present. On the other hand, they pose serious environmental issues such as the fire hazard of gin waste piles, if merely discarded. Therefore, it is necessary to find alternate uses or disposal strategies for these waste materials without adding additional cost to the producers.

#### Action

The focus of this research project is to generate value added products from the two waste streams coming from cotton agriculture, the gin waste and bale wraps. Cotton gin waste is rich in natural ligno-cellulosic fibers, which may be used to replace the more expensive wood fiber in composite boards. Similarly, cotton bale wraps may be able to replace part of the high-density polyethylene in composite boards, without compromising the mechanical and physical properties of the end products. Therefore, we evaluated the two waste materials for potential application in fiber-reinforced thermoplastic composite boards. Formulations for the composites selected based on lab studies were tested at a commercial scale in 2009 at Greenland Composites Inc. We have also characterized the burr and linter fraction of the cotton gin trash for chemical and physical properties. Testing of these composite boards for physical and mechanical properties showed that they have comparable properties and good potential to be used in building applications.

#### Impact

It is important to protect our environment for future generations, and to help rural communities by making agriculture more profitable. The new composites made with cotton gin waste and recycled bale wrap will add value to two of the waste streams from cotton agriculture, and reduce their environmental impact by removing them from the environment. The new composite material made from these materials will have lower costs as the raw materials are inexpensive. The cotton farmers will benefit from this product by selling the cotton gin waste for a price instead of paying for its disposal. The many wood-plastic composite industries situated in the cotton belt will benefit from this product by substituting the scarce and expensive raw materials with inexpensive and abundant raw materials that are locally available.

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#### Funding

Cotton Inc.; University of Arkansas Division of Agriculture

## Environmental resource management to develop watershed technologies and management tools

#### Issue

Water is a natural resource that is seriously impacted by anthropogenic factors such as urbanization and agriculture, and natural processes such as soil erosion, among other things. Although there has been significant research into the processes that affect water quality, a lot of it is still unknown. A true evaluation of the effect of natural processes and anthropogenic factors on water quality will require monitoring and modeling of these processes and the changes they cause in the landscape.

#### Action

This research focuses on combining remote sensing techniques with transport models to capture the dynamic soil erosion processes that affect water quality. One of the major research focuses is on identifying the source of the sediments in the deteriorated West Fork of White River (WFWR) Watershed. We have developed a method using aerial remote sensing combined with photogrammetric analysis to characterize stream bank erosion in selected reaches of WFWR Watershed. We have quantified land use land cover changes in the last 20 years using remote sensing. Currently, we are analyzing the impact of change in land use land cover on upland contribution of sediments to the river using two models, AnnAGNPS and SWAT.

#### Impact

It is important to protect our natural resources for future generations. The new remote sensing based method for quantifying stream bank erosion has the potential to look at whole stretches of the river instead of individual cross-sections. A clear understanding of the various sources of pollution of surface waters, and the mode of action of these pollution sources is critical to develop remediation techniques or best management practices that would either control the sediments based on the source of the sediments (stream bank vs upland).

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#### Funding

EPA Region 6; Honors College Grant (for undergraduate research); University of Arkansas Division of Agriculture

# Development of a distributed artificial neural network model for hydrologic modeling

#### Issue

Rainfall-runoff process is a highly complex distributed process that depends on geo-morphology of the terrain. Distributed deterministic models for simulating the rainfall-runoff process are too complex and require an extensive amount of spatial data. Though artificial neural network (ANN) models are computationally efficient and highly accurate, most ANN models representing hydrological processes are lumped models with no capability to represent the spatial dynamics of a watershed. A distributed ANN (dANN) model can benefit from the inherent accuracy and efficiency of ANN models, while providing a mechanism to represent the spatial dynamics of the process within a very complex watershed.

#### Action

This research focuses on developing a distributed artificial neural network model for representing the rainfall-runoff process in a sample watershed. The L'Anguille River Watershed is chosen to evaluate the dANN model. The dANN model replicates the concept of dividing the watershed into a group of connected hydrological response units (called subbasins) that interact with each other by contributing flow to one another. Such relationship is replicated in the dANN model with the help of a set of spatially connected neurons that represent the subbasins. The temporally changing characteristics of each subbasin such as curve number, rainfall, temperature, etc form the input to the corresponding neuron, with the output being the flow at the subbasin outlet. The dANN model was compared to SWAT model based on speed, accuracy and ability to represent the spatial flow in the L'Anguille River. A paper was published in Transactions of the ASABE and another paper in Inquiry based on this work.

#### Impact

We have developed a new distributed ANN model, which has high accuracy and computational efficiency while accurately representing the spatio-temporal dynamics of rainfallrunoff process. This model has the potential to analyze the effect of various parameters on runoff process (sensitivity analysis), identify high runoff contributing areas and effect of land use land cover change on runoff process. Such a model can be implemented relatively inexpensively and accurately to implement best management practices to critical areas in the watershed to reduce flow and erosion and to improve water quality. This project concluded in 2009.

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#### Funding

SURF Grant; University of Arkansas Division of Agriculture

# An ammonia emission mitigation system for commercial broiler houses

#### Issue

Air quality impacts from confined animal feeding operations is an emerging issue. Potential regulations could affect the economic viability of animal agriculture. Ammonia and particulate matter are the two pollutants of concern emitted from poultry houses. Mitigation of ammonia emission from broiler houses would be important for future viability of broiler operations and for protecting the environment and community health.

#### Action

This project aims at developing a simple and effective at-source mitigation system for reducing ammonia emission from commercial broiler houses. Preliminary analysis of a twocomponent mitigation system that combined a water scrubber with a biofilter to treat the exhaust air from a broiler house showed poor effectiveness. Currently, we are modeling and designing a biofilter constructed using silage bags and operating with a dedicated fan to improve air quality in the house while immobilizing ammonia in the air into the filter medium (waste forest, crop or manure residues). This proposed mitigation system is expected to be non-hazardous, easily disposable and will have minimal impact on water and air quality at disposal.

#### Impact

Arkansas could be seriously impacted by evolving air quality issues, if they are not addressed immediately. As most biofilters have shown to remove 90-95% of the ammonia from the treated air, we expect that the bag biofilter system will have high effectiveness while being more compact in size and easy/ inexpensive to construct and implement. As the treated air is circulated back to the house, this system is expected to provide significant bird and human health benefits while reducing the ventilation requirements. The immobilization of ammonia in the filter bed would provide major environmental quality benefits. The spent filter media rich in immobilized N could be land applied as a bio-fertilizer for uptake to crops, thereby avoiding re-release of ammonia to the airshed.

#### Contacts

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#### Funding

USDA-NRI; University of Arkansas Division of Agriculture

# Comparison of two instruments for monitoring particulate matter in broiler houses

#### Issue

Particulate matter (PM) and ammonia are two of the major emissions of concern produced from broiler houses. There are some controversies surrounding the methods and instruments used for monitoring PM from animal feeding operations (AFO), mainly because some of the researchers claim that many of the standard instruments have a bias against the PM with the size distribution of what is emitted from AFOs. They claim that these instruments tend to exaggerate the PM emissions because they were designed to monitor PM with different size distributions than that from AFOs.

#### Action

This project compared two PM monitoring devices, the Tapered Element Oscillating Microbalance (TEOM) and Dust-Trak for 10 days in Fall of 2009. TEOM is considered as the standard equipment for PM monitoring by many researchers. Both instruments monitored PM10 for 7 days and PM2.5 for 3 days. The results indicated that TEOM. The results indicated that on average, TEOM measurements were 600  $\mu$ g/m<sup>3</sup> higher than DustTrak for PM 10 and 25  $\mu$ g/m<sup>3</sup> higher than DustTrak for PM2.5.

#### Impact

Particulate matter is a criteria pollutant and therefore, regulated by EPA. If the emission of PM exceeds EPA criteria, EPA can penalize the producer or integrator, not to mention issues with environmental groups. Therefore, it is necessary for scientists, producers and other stakeholders to understand the accuracy of the instrumentation in order to properly comply with federal regulations.

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#### Funding

University of Arkansas Division of Agriculture

# Arkansas robber flies as insects of conservation concern and potential biological control agents

#### Issue

Robber flies comprise one of the most diverse, abundant, and conspicuous families of flies. More than one thousand species are known to occur in North America. Over the past half century, the scientific community has become increasingly interested in these flies as indicators of environmental health and as potential biological control agents.

Adult robber flies are opportunistic, aerial predators of many kinds of insects. Larval stages are spent in soil, among plant roots, or in decaying wood—usually within the galleries of wood-boring insects. Asilid larvae are predators, ectoparasites, or parasitoids, feeding on eggs, larvae, or pupae of other insects. Most successfully-reared species have been shown to feed on white grubs (Coleoptera: Scarabaeidae).

Robber flies have been collected from nearly all habitats, but each species has its own habitat affinities. Most species have restricted ecological requirements and are locally distributed.

#### Action

Before the present survey was started, only 42 species of robber flies from Arkansas were recorded in the published literature. Recent collecting and analysis have resulted in a checklist of 131 species, of which 66 species were recorded for the first time from the state. The Arkansas robber fly fauna has close affinities with the fauna of the eastern United States.

Several robber fly species are rare in Arkansas, and they may deserve to be classified as species of special concern. Revision is completed on the poorly known genus *Ceraturgus* in North America, all species of which are rare throughout their ranges, and the genus *Atomosia*, which included a description of rare new species, known only from the endangered blackland prairie habitat of Hempstead County, Arkansas.

A review of the genus *Stichopogon* in North America was started in 2009. Several thousand specimens have been borrowed from 35 insect collections around the United States and Canada. More than half of the specimens have been databased and mapped.

#### Impact

Robber flies are significant elements of the ecosystem. They are excellent candidates for ecological monitoring and potential biological control agents for pest insects. Many remnant prairie areas that are protected by the Arkansas system of natural areas hold several of the specialized robber flies, thus they can help provide indicators of changes in those habitats. Conservation requires a modern review of the state's robber fly species. This project summarizes all that is known about the robber flies occurring in Arkansas and set the stage for further research of economic and conservation concern.

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#### Funding

University of Arkansas Division of Agriculture

# University of Arkansas Arthropod Museum supports extension, research, and education missions

#### Issue

Arthropods are the earth's most diverse organisms. Over 60% of all known species, both plant and animals, are arthropods (insects, spiders, mites, crustaceans, and related groups). The insects account for over half of all species described thus far, and they are the dominant form of life in terrestrial environments. There are perhaps 35,000 or 40,000 known species of arthropods recorded from Arkansas, and it is still not uncommon to find species here that are unnamed and new to the scientific world. The University of Arkansas Arthropod Museum (UAAM) houses the largest research and reference collection of insects and other arthropods in the State of Arkansas. An extensive literature collection is at hand to facilitate timely identification of pests, beneficial species, and other species of concern. The Curator provides identification and information services to extension personnel, researchers, and the general public. Loans of specimens are sent to interested researchers around the world. Auxiliary collections are maintained for demonstration and teaching purposes. A growing website is dedicated to assisting the Museum in its extension, research, and education missions.

#### Action

In 2009, seven new popular articles authored by the Curator were added to the *University of Arkansas Arthropod Note* series on the Museum's website: squash bugs, No. 62; copper underwing, No. 63; purple small-headed fly, No. 64; moth flies, No. 65; giant swallowtail, No. 66; Carolina sphinx, No. 67, and tersa sphinx, No. 68. The 68 articles in the series receive wide notice and praise. Also, an invited entry by the Curator on the general topic of Arkansas insects was published in the wellregarded online *Encyclopedia of Arkansas History and Culture*.

#### Impact

The Museum's collection serves as the major reference resource for arthropod identifications in the State of Arkansas. Identification of specimens assists researchers, government agencies, businesses, and individuals in their efforts to control insect pest problems and protect the environment. Each year, Museum specimens are displayed at various venues, giving upwards of 15,000 citizens some exposure to the world of insects. The Museum website reaches out to researchers with a bibliography of Arkansas arthropod biodiversity, and it reaches out to extension specialists and the general public with a series of illustrated popular articles on important and interesting regional species.

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#### Funding

University of Arkansas Division of Agriculture

# Ozark subterranean insect diversity and protection of groundwater resources

#### Issue

Groundwater habitats provide crucial ecological services and sustain rich endemic communities, 90% of which remain undescribed. Despite the importance of subterranean habitats, they have received very little study by the scientific community. Less than 10% of an estimated 1000 troglobitic Ozark Plateau species have been described from this ecoregion. (Troglobites are obligate cave dwellers so completely adapted to caves that they are restricted to this environment.) Little is known about the distribution of species and their limiting factors. Very few food webs have been described, and nutrient dynamics are poorly understood. Knowledge of subterranean ecosystem dynamics is needed not only for the protection of the groundwater resource, but because its denizens are among the world's rarest and most endangered freshwater fauna and are underprotected in the existing network of preserves.

The goals of the Arkansas Subterranean Biodiversity Project are to discover and protect the diversity of life underground, to investigate ecosystem processes of subterranean habitats, and to preserve cave and groundwater resources for future generations. Project cooperators inventory underground and aquatic habitats, inventory karst features, survey caves and define recharge basins, monitor environmental quality, monitor cave populations, and create educational outreach tools and programs. Ground water supplies 62% of the overall water demands of the United States, yet little is known about groundwater ecosystems.

#### Action

Many cave systems, several containing federally listed endangered species, are being investigated in this effort to understand and preserve the underground biodiversity of the Ozarks. The Arkansas Natural Heritage Commission, Arkansas Soil and Water Conservation Commission, Arkansas Department of Environmental Quality, The Nature Conservancy, U. S. Forest Service, U. S. Geological Survey, and U.S. Fish and Wildlife Service are all cooperators in this effort. The University of Arkansas Arthropod Museum and its Curator are also project cooperators. The Museum is a repository for insects and other arthropods collected by the Subterranean Biodiversity Project. The Curator identifies insects, especially Diptera and Coleoptera, collected during the Project.

#### Impact

Understanding the biotic diversity of Arkansas subterranean habitats and the role of the biota in indicating stresses on the habitats will help in developing long-term plans to manage those habitats. The outcome of the studies and a sustainable management plan will be better protection of groundwater ecosystems and the services they provide to the state.

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#### Funding

University of Arkansas Division of Agriculture

## Long-term soil chemical property changes as affected by broiler litter application rate

#### Issue

The concentration of broiler industry in northwest Arkansas generates large quantities of nutrient- and metal-enriched litter. Broiler litter is then typically land applied for disposal and a means to recycle the material as an organic fertilizer source. However, over time, increasing nutrient and metal concentrations in the soil can create the potential for negative environmental impacts if nutrient and metal mobility in the soil is enhanced from physical or chemical alteration of soil properties contributing to their storage in the soil profile.

#### Action

A study was initiated in Spring 2003 on small-scale, closely manageable plots at the Agricultural Research and Extension Center in Fayetteville, Ark. to evaluate the long-term effects of broiler litter application rate on soil profile properties, particularly soil nutrient and heavy metal contents. Broiler litter was applied annually at 0, 5.6, and 11.2 Mg ha<sup>-1</sup> over a 5-yr period. Soil was sampled annually to a 90-cm depth at 10-cm increments and characterized for acid-recoverable, Mehlich-3extractable, and water-soluble P, K, Ca, Mg, S, Na, Fe, Mn, Zn, Cu, Al, As, and Cr, and pH, electrical conductivity, organic matter, and dissolved organic carbon. This objective was part of a wider study goal, which was to investigate the long-term broiler litter application rate effects on runoff, leaching, plant uptake and removal, and changes in soil storage of litter-derived nutrient and heavy metals.

#### Impact

Based on the first five years of data collected in this longterm study, annual applications of broiler litter caused twothirds of macro-nutrients and one-third of micro-nutrients/ trace metals studied to increase over time in the soil profile, while nearly one-half of the macro-nutrients and one-fifth of the micro-nutrients/trace metals studied decreased over time in the unamended control. Study results showed that the majority of macro-nutrient changes were located in the upper soil depths, while the majority of the micro-nutrient/trace metal changes were located in lower soil depths. Results indicate that soil macro-nutrient changes may pose potential negative environmental impacts near the soil surface via runoff, whereas soil micro-nutrient/trace metal changes may pose potential negative environmental impacts in the sub-soil via leaching.

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#### Funding

University of Arkansas Division of Agriculture, Agricultural Experiment Station

## Broiler litter history effects on arsenic adsorption to soil

#### Issue

The Ozark Highlands, particularly northwest Arkansas, is one of several regions in the United States with concentrated broiler production. In Arkansas alone, over 1.2 billion broilers are raised annually, which also generates ~1.7 million Mg of broiler waste (i.e., litter) every year. Broiler litter is typically land-applied to surrounding pastures as a means of recycling the litter as an organic fertilizer. However, broiler litter also contains numerous heavy metals, specifically arsenic (As). Adsorption to soil particles is a primary means of As retention in soil that limits As mobility and the potential threat of water contamination. However, As also competes with phosphorus (P) for adsorption sites. Therefore, it is essential to understand how broiler-litter-derived As behaves in a high-soil-test-P environment, which characterizes many of the pastures of northwest Arkansas and the Ozark Highlands.

#### Action

To address this issue, a laboratory adsorption study was conducted to evaluate the effects of a history of broiler litter application rates (i.e., 0, 5.6, and 11.2 Mg litter ha<sup>-1</sup>) and soil depth [0-20 cm and 20-50 cm representing a high organic matter (OM)/low clay and low OM/high clay combination, respectively] on As adsorption to soil and to evaluate the effects of the presence of added P on As adsorption to soil. Soil samples were obtained for actual field plots that had been amended with the above-stated litter rates for four consecutive years. A series of nine As concentrations ranging from 0 to 25 mg L<sup>-1</sup> with and without constant P (~3 mg L<sup>-1</sup>) were added to 1 g of air-dried soil collected from field plots representing each of the treatment combinations and were allowed to equilibrate on an end-over-end shaker for 24 h.

#### Impact

Results showed that As adsorption was greater to the soil of the unamended control than to the soil of the low (5.6 Mg ha<sup>-1</sup>) and high (11.2 Mg ha<sup>-1</sup>) litter treatments and As adsorption was also greater in the 20- to 50-cm depth than in the 0- to 20cm depth whether additional P was present or not. However, As adsorption in the presence of constant P was nearly twice that when only As was present indicating that, under these experimental conditions, As and P were likely co-precipitated out of solution to appear as if increased adsorption was occurring. Nonetheless, these results suggest that there may be less of a potential to increase As mobility in the soil when broiler litter is land-applied containing both As and P; thus the potential threat to groundwater contamination from increased As leaching may also be less than once thought.

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### Towards cellulosic derived biofuels

#### Issue

This research program is concentrating on next generation biofuels production. The term 'next generation' implies that the liquid fuels will not be produced from starch, but from cellulosic biomass, such as herbaceous and woody feedstocks. The objectives of this research program are to: 1) determine conditions in which cellulosic biomass can be pretreated before being converted to biofuels, such that a maximum amount of carbohydrates are released; and, 2) to insert, whenever possible, an extraction operation aimed at extracting valuable phytochemicals from the biomass prior to pretreatment. **Action** 

In the enzymatic platform, the production of biofuels implies the release of cellulose and hemicellulose from the biomass cell wall by a combination of pretreatment and enzymatic steps. This research program is focused on understanding how the hemicellulose breaks down to single sugars, which can then be fermented to biofuels. Unfortunately, hemicellulose depolymerization is not simple because it breaks down into pieces of sugars that later lead to the formation of undesirable degradation products, such as furfural, which inhibit the fermentation. We are working at determining processing conditions that minimize the production of furfural. In a parallel fashion, we are also working at devising strategies to extract valuable phytochemicals from the biomass prior to the pretreatment and enzymatic steps. We are developing these extraction steps such that they are performed with water so that they do not hinder the pretreatment and enzymatic steps. The extraction of phytochemicals may add value to the overall biorefinery operation

#### Impact

Arkansas is rich in biomass that could be used for production of biofuels using next-generation technology for extraction of cellulose and hemicellulose from herbaceous and woody feedstocks.

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NSF Project #0828875, DOE Project # FG36-08GO88036; University of Arkansas Division of Agriculture

#### Impact of draining rice fields

#### Issue

Water costs for producing rice in Arkansas have been increasing in the recent past due to a combination of deeper available water, increased fuel and energy costs and two extremely dry summers. Ways to reduce these costs are needed very much. One way to reduce these costs is to drain rice fields for harvest at a time that will allow water savings and a low likelihood of reducing rice yield or quality.

#### Action

A computer program to drain rice fields based on stages of development has been developed. The program includes inputs from farmers on variety, soil and heading date. The results from the program are predicted dates for successive reproductive rice growth stages, water use during each stage and a predicted stage of development for draining that will allow the field to be drained; and the water held in the soil at draining will allow the crop to develop to maturation without experiencing a yield- or quality-limiting water deficit.

The model has been tested for five years in the field against later draining control treatments. Yields have not been reduced for the treatments drained by the program compared to the control treatments in any year. Head rice yields have not been reduced in any year so far for the treatments drained by the computer program compared to later drained controls.

#### Impact

We find a usual minimum water savings of one less 3-inch

irrigation. Water savings from one less 3-inch irrigation would be \$4.15 per acre for a water depth (depth to pump) of 50 feet. Water savings would be \$22.45 per acre for a water depth (depth to pump) of 300 feet. Other potential savings include reduced tillage costs due to harvesting in wet soil conditions. Moreover, earlier draining of rice fields would result in less depletion of aquifers.

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#### Funding

Arkansas Rice Research and Promotion Board; University of Arkansas Division of Agriculture, Arkansas Agricultural Experiment Station

## Evaluation of physical properties of biocontainers as compared to traditional petroleum-based plastic containers

#### Issue

Greenhouse and containerized nursery crops are grown in containers of various sizes. Petroleum-based plastics have been the materials of choice for the manufacture of greenhouse and nursery containers because they are strong and can be formed to essentially any size, shape or color. However, the extensive use of plastic containers has also resulted in significant waste disposal problems. As the greenhouse and nursery industries have become more focused on increasing the sustainability of their operations, the amount of waste plastics generated by greenhouses, has become a significant issue of interest. Although recycling of containers is an option in certain situations, reducing the use of plastic containers by increasing the use of biocontainers is one strategy that could reduce the amount of waste plastic generated by greenhouse operations.

#### Action

The physical properties of water use, dry strength, wet strength, algal/fungal growth and decomposition were evaluated for eight biocontainers compared to traditional petroleum-based plastic containers. Physical properties varied significantly among the different types of containers. In particular, Cowpot, peat and Fertil biocontainers were found to have low wet strength that would be problematic for growers with respect to handling and shipping. Peat, straw, cocofiber and Fertil biocontainers required significantly more water to grow a crop to a marketable stage than other biocontainers as well as traditional petroleum-based plastics. Ricehull and OP47 biocontainers had physical properties similar to traditional petroleum-based plastic containers.

#### Impact

The information generated from this research will allow

manufacturers to improve biocontainer properties and will allow greenhouse and nursery managers to make decisions regarding which biocontainer(s) would be most suitable for their operations. Ultimately, the results of this research will help to reduce the use of petroleum-based plastics in greenhouse and nurseries and reduce waste plastics.

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University of Arkansas Division of Agriculture

# Evaluation of a dairy manure composted product as an alternative component to peat in containerized greenhouse production

#### Issue

Sphagnum peat (peat) is a standard root substrate component used for containerized greenhouse and nursery crops production. However, peat is considered a non-renewable resource and its harvest results in the loss of ecosystems. Animal manures represent a waste disposal issue for the animal production industry. The use of animal manures as alternatives could result in a reduction in the harvest of peat and provide a value-added means of utilizing animal manures. Ecosolve® is a specially processed, composted and stabilized dairy manure product that has been purported to have consistent physical and chemical properties that would allow it to be effectively used as a substrate component as an alternative to peat.

#### Action

The physical and chemical properties of Ecosolve® and Ecosolve®-containing root substrates where evaluated and compared to standard substrates composed of peat. Ecosolve® had physical and chemical properties within acceptable ranges except for having a high pH. When blended into peat-based substrates at rates of up to 30% Ecosolve®, the substrates had suitable physical and chemical properties. Therefore, Ecosolve® could be used as a partial replacement for peat in root substrates. Greenhouse-based plant production trials were performed and crops grown in substrates containing up to 30% Ecosolve® were of similar quality crops grown in 100% peat-based root substrates.

#### Impact

The results of this research demonstrate that Ecosolve<sup>®</sup> could be used as an effective partial replacement for peat. This could result in a decreased reliance on peat and an increased use of processed animal manures as root substrate components.

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#### Funding

Tyratech, LLC University of Arkansas Division of Agriculture

# Understanding spatial and temporal aspects of American woodcock (*Scolopax minor*) winter habitat use in Central Arkansas

#### Issue

The American woodcock (Scolopax minor) is a migratory bird species whose ecology is not well understood in portions of its wintering range and whose populations have exhibited long-term (1968-2008) declines throughout its breeding range. The U.S. Shorebird Conservation Plan lists woodcock as a species of high concern, and many states, including Arkansas, list the woodcock as a species of greatest conservation need. Much of the research assessing woodcock habitat has been conducted in their northern breeding grounds, but little information exists that quantifies characteristics of woodcock wintering habitat, especially in the Central Region. Additionally, little empirical evidence exists to understand temporal aspects of woodcock use of areas during winter or migration stopover. Current management plans have indicated a need to investigate characteristics of woodcock wintering and stopover habitat use, as well as factors contributing to declines.

#### Action

A project was initiated during winter 2008, and will continue for the next year with the assistance of a graduate student who began August 2009. The goals of this project are to enhance the understanding of woodcock ecology and conservation of vegetation communities used by woodcock in central Arkansas by determining vegetation types and locations of areas used by woodcock in central Arkansas during the winter months, and evaluating the efficiency of methods used to identify woodcock locations. Methods included using thermal imaging to detect woodcock along routes comprised of forested stands and openings, and auditory and visual crepuscular (dusk) surveys of woodcock presence in new clearcuts, young pine plantations, and older plantations (with trees < 3 m tall).

#### Impact

This research is widely applicable and will advance knowledge on woodcock ecology that will benefit populations throughout the Central Region of the United States. The intent is to establish research partners and develop long-term cooperative studies that aim to understand the relationships between woodcock winter habitat and breeding habitat. Results will facilitate a deeper understanding of woodcock ecology and identify areas for proactive woodock conservation strategies.

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#### Cooperators

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#### Funding

UAM Faculty Research Grants; University of Arkansas Division of Agriculture

## Efficacy of non-invasive techniques for surveying feral hog populations in southern Arkansas

#### Issue

Feral hog (Sus scrofa) populations are expanding throughout many areas of the United States. Negative impacts of feral hogs on native ecosystems, water quality, and other animal or plant populations have been documented. Research has also documented the capacity of feral swine to cause extensive and expensive agricultural damage through rooting and wallowing activities and transmit diseases such as swine brucellosis (Brucella suis) and pseudorabies. For these reasons and others, many state and federal agencies, conservation organizations, and private landowners have been compelled to implement removal strategies to control hog populations and alleviate their negative ecological and economic impacts. Currently, many wildlife agencies and landowners implement feral hog population control by shooting or trapping; however, it is not clear how efficient management efforts are, in part because feral hog distributions and movement patterns are unknown. There is a need to identify efficient and effective methods to survey and monitor feral hog distributions and movement patterns in order to develop management strategies to control feral hog populations. To date, no attempts have been made to document the distribution of feral hogs in Arkansas. Furthermore, little research has been conducted to identify cost effective and efficient methodologies to survey and monitor feral hog distribution in Arkansas.

#### Action

Several non-invasive methods such as fecal counts, passive tracking indices, sign counts, and non-invasive genetic sampling have been used to monitor the distribution of wildlife populations. Tracking plots, however, do not allow collection of other important demographic data such as sex structure or individual identification and their success largely depends on weather and soil type. Hair snaring has proven to be a practical noninvasive method to estimate population abundance and distribution for several wildlife species, particularly carnivores. This technique, however has not been explored as a method for understanding feral hog populations. Hair snaring could be a practical, efficient, and inexpensive non-invasive method for understanding the distribution and population structure of feral hogs because it is inexpensive relative to other survey methods such as remote cameras or radio-tracking equipment. Barbed wire is capable of snagging hair from feral hogs, and hair snares may be a reliable method for identifying individuals and understanding genetic structure of feral hog populations through DNA analysis. Therefore, our objectives are to evaluate and compare the use of hair snares and tracking plots as methods for determining spatial distribution of feral hogs in Drew County, Arkansas, and evaluate the use of hair snares as a non-invasive method to collect feral hog demographic data and determine the genetic structure of populations.

#### Impact

The proposed study will evaluate and compare the use of hair snares and tracking plots as techniques for surveying the

distribution of feral hogs in southern Arkansas. Because feral hog hair and tracks are easily distinguishable from those of other wildlife, both methods will permit collection of feral hog presence-absence data. Using GIS, locations indicating presence of feral hogs can be plotted on maps to determine feral hog spatial distribution throughout the study area. Evaluation and comparison of different survey techniques will provide empirical data on which survey methods can be selected based on reliability and efficiency in terms of cost and time. Pending data quality and sufficient funding, the study will also evaluate the use of genetic analyses of DNA extracted from feral hog hair as a reliable method for understanding genetic structure of feral hog populations, and identification of the spatial distribution of individual sounders. Results will provide insights on how well non-invasive collection of DNA for genetic analysis might work as a mark-recapture technique to estimate size of feral hog populations, evaluate movement patterns of sounders, or understand population responses to specific management activities such as removal.

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#### Funding

Berryman Institute; Arkansas Game and Fish Commission; University of Arkansas Division of Agriculture

#### Land use effects on stream water quality

#### Issue

The degradation of water resources throughout Arkansas is a critical environmental concern, as the quality of our streams, rivers, and reservoirs are vital to the natural beauty and tourism of our state, as well as, ultimately, the health of the Gulf of Mexico. The input of nutrients from anthropogenic sources into streams, rivers, and reservoirs can accelerate the natural process of eutrophication and impair water quality and the water bodies designated beneficial uses. These issues must be addressed at the larger watershed scale, and require evaluation across defined land use gradients.

#### Action

In order to properly manage and protect our water resources, we need to know where these nutrients come from, how they get to streams and lakes, and when most of these losses occur. It is also vital to know what happens to these nutrients once they leave the edge of a field and enter a stream or river, in order to determine or even predict how receiving water bodies will be influenced. This will require a multidisciplinary understanding soil–water–nutrient interactions, fluvial channel processes, and internal lake or reservoir mechanisms that can influence water quality. Several projects are evaluating the changes in physical, chemical and biological conditions of streams draining catchments across a gradient of land uses (e.g., forest, pasture and urban).

#### Impact

These multidisciplinary approaches have been applied

in targeted watersheds across northwest Arkansas (i.e., the Eucha–Spavinaw Basin, Illinois River Basin and White River Basin). The contributions from nonpoint sources and municipal wastewater treatment plants to annual nutrient loads have been identified, and this allows farmers, cities, and watershed managers to better focus efforts to reduce nutrient inputs from the landscape and critical effluent discharges. Furthermore, we have an increased understanding of how fluvial channel and reservoir processes influence nutrient transport and can act as nutrient sources or sinks, which allows us to communicate to stakeholders the importance of these processes and potential nutrient sources when considering watershed management strategies that will influence a diverse and wide range of stakeholders within the watershed.

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University of Arkansas Division of Agriculture, USDA Agricultural Research Service, USDA CSREES Nutrient Science for Improved Watershed Management Program, U.S. Geological Survey State Water Resources Institute Research Program, U.S. Environmental Protection Agency, Cities of Fayetteville, Springdale and Rogers, Illinois River Watershed Partnership and Arkansas Natural Resources Commission

# An environmentally friendly option to extract procyanidins from grape waste

#### Issue

Abundant quantities of natural grape waste, called pomace, are produced by the juice and wine industries. The pomace, which consists of skins, seeds, and skins, is often discarded as waste, used for animal feed, or soil fertilizer. The pomace is a rich source of polyphenolics, especially anthocyanins and procyanidins, which are purported to protect against chronic diseases through their ability to modulate a variety of biochemical processes. Polyphenolics, including procyanidins are commonly extracted from pomace using aqueous mixtures of organic solvents, which are expensive and environmentally unfriendly. Extraction processes employing environmentally friendly solvents are needed to extract polyphenolics for incorporation into foods, pharmaceutical, or cosmetic products.

#### Action

An environmentally friendly technique called accelerated solvent extraction (ASE), which uses pressurized heated solvents, was used to extract procyanidins from red grape pomace. Six ethanol/water solvents (0, 10, 30, 50, 70 and 90%, v/v) tested at temperatures of 40, 60, 80, 100, 120 and 140 °C were compared to conventional extraction with an acetonebased solvent at ambient temperature. Procyanidin monomers, oligomers (DP 2-5) and polymers (DP>10) were analyzed by HPLC. Generally, 50% ethanol/water extracted more total procyanidins than other ethanol/water mixtures, but contained only 66% of total procyanidins extracted by the acetone-based conventional solvent, due to inefficient polymer recovery. However, 50% ethanol/water extracted 205, 221 and 113% more epicatechin, catechin and dimers, respectively, than conventional extraction. Results indicated greater extraction of low oligomeric procyanidins using 50% ethanol/water solvent between 80 °C and 140 °C.

#### Impact

Ethanol/water mixtures were much more effective than conventional solvent in extracting low molecular weight procyanidin monomers and dimers from red grape pomace. This is important as the low molecular weight monomers and dimers are the only procyanidins that are absorbed in the body to contribute to health benefits associated with procyanidins. The results from this research provide the wine and grape juice industries with an environmentally friendly option to extract procyanidins from grape waste for further use as nutraceuticals or nutritional supplements.

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#### Funding

University of Arkansas Division of Agriculture

## Micro/nanoscale BIO/ABIO interfacing technology

#### Issue

The biomaterials, including DNA, proteins, and cells, are well optimized through evolution, exhibiting unique recognition, transport, catalytic, and replication properties. Instead of reinventing the wheel, the integration of such pre-engineered biomaterials into nano systems would lead to the realization of the next generation bio/abio hybrid engineered systems for applications raging from MEMS/NEMS-based micro/nano fluidic systems to bioelectronic and biosensing systems. However, the major challenges for making this merger feasible are integration and interfacing of the micro- and nano-scale biological and abiological materials at similar scales. The successful development of interfacing techniques for their integration is imperative to overcome the challenges.

#### Action

Currently, we are in the process of developing a series of nano hybrid devices through stable and 'controllable' interfaces between bio and abio materials at the nanoscale. These devices as well as materials under investigation in my laboratory include (a) a nano flagellar motor based AC dynamo (nFMD), (b) a nano flagellar motor based TNT detection system (nF-MTNT), (c) a DNA-based CNT wire (DNA/NTW) nanosensor, and (d) a photothermal diagnostic and therapeutic system using near-infrared responsive nanoparticles.

#### Impact

These projects are important steps towards realization of

the bio/nano nanotechnology that bridges the sciences of biology, medicine, nano-materials, and MEMS/NEMS by pairing their advantages.

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#### Funding

National Science Foundation (NSF; award #: CMI-0709121, ECS-0401196, and CMS-0508435), National Research Initiative (NRI) of the USDA-CSREES (award #: 2005-35603-15902), and Arkansas Bioscience Institute (ABI); University of Arkansas Division of Agriculture

# Non-crosshybridizing DNA oligonucleotides for DNA-based nanotechnology and DNA computing

#### Issue

When used to self-assemble nanostructures for biological, medical and electronic applications, DNA oligonucleotides can form unplanned duplexes (cross-hybridizations), which could result in defects. Likewise, crosshybridizations can produce errors in the results of DNA computations. Thus, there is a need for libraries of oligonucleotides that minimize crosshybridization.

#### Action

In my laboratory, in vitro methods have been developed and verified to produce large libraries with thousands of DNA oligonucleotides that interfere minimally with each other. These libraries are being used to self-assemble complicated nanostructures, for molecular electronic, medical and sensor applications, with greater control of component location to overcome the fundamental physical limits.

#### Impact

The libraries of DNA oligonucleotides produced in our laboratory should be useful for a variety of biological, biomedical, and other applications, particularly as DNA oligonucleotide building blocks for DNA-based computers and nanotechnology.

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#### Funding

National Science Foundation (NSF; award #: award #: CMI-0709121, CCF-0523858, and CCF-0407218); Arkansas Bioscience Institute (ABI); University of Arkansas Division of Agriculture

# Point estimates of ammonia volatilization from the litter floor of commercial poultry houses during growout

#### Issue

Ammonia emissions from mechanically-ventilated livestock houses can be quantified by measuring whole house ventilation rates and ammonia concentrations at the air inlet and fan outlets. It remains a challenge to accurately determine emissions from naturally-ventilated buildings (i.e. some broiler and turkey buildings), since air exchange is distributed and hard to quantify. Furthermore, the whole-house technique does not provide any information as to locations within the building where emissions may be concentrated and where abatement techniques should be targeted.

#### Action

A side-by-side comparison between the flux chamber method and simultaneous whole-house measurements was conducted during two winter flocks and one summer flock of commercial broilers raised on reused litter at the University of Arkansas Applied Broiler Research Farm. A dynamic flux chamber was used to measure ammonia flux rates from the litter floor on a weekly basis. Composite flux rates, from point measurements, were compared to simultaneously measured whole-house ammonia emission rates. Generally, there was a linear trend between two flux measurement methods, with ammonia flux tested by chamber method lower than whole house measurement. The effect of litter temperature and moisture contents on flux rates are under investigation. Spatial variability of flux within the house is also being investigated.

#### Impact

This study will provide research-based guidelines to establish ammonia flux measurements as useful tools to assess interior ammonia volatilization phenomena on both mechanically and naturally ventilated litter-based poultry buildings. The calibrated methods can be used in further studies aimed at comparing flux rates associated with alternative litter sources/ treatments, litter management methods, and animal diets. Unlike whole house measurements where replication requires multiple houses, flux chamber studies can utilize replication within each building. This technology could allow a more rapid evaluation of proposed emission abatement strategies.

#### Contacts

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University of Arkansas Division of Agriculture

# Sterile butterfly bush hybrid is non-invasive

#### Issue

Invasive plants set abundant seed, spread from cultivation, exclude native species and disrupt ecosystem processes. Regulations concerning the cultivation and sale of invasive plants now affect commerce of certain ornamental plants. Oregon recently prohibited the sale of *Buddleia davidii*, butterfly bush, and this plant is classified as a class B noxious weed in neighboring Washington State. It is imperative that ornamental plant breeders develop sterile alternatives to these plants and also establish guidelines by which the sterility of these plants is assessed. This will ensure that these plants are indeed sterile and will not spread from the cultivated landscape.

#### Action

Since 1999, an ornamental plant breeding program in *Buddleia* has been ongoing in the University of Arkansas Division of Agriculture. The program released a sterile, *Buddleia* hybrid named 'Asian Moon'. This release was the result of a cross between the tetraploid species *B. davidii* and the diploid species *B. asiatica*. The resulting interspecific hybrid was a triploid and thus presumed to be sterile. The analyses done to show that this plant was indeed sterile included flow cytometry, chromosome counts and fertility tests done in the presence of other *Buddleia* species and hybrids. In all cases, 'Asian Moon' was shown to be sterile.

#### Impact

'Asian Moon' is currently one of the few *Buddleia davidii*like butterfly bush hybrids legal for sale in Oregon. The suite of characteristics used to show that this plant is sterile is now being applied to other butterfly bush hybrids proposed for sale in states where the sale of *Buddleia davidii* is restricted. Because of breeding done at the University of Arkansas Division of Agriculture, consumers can still purchase and plant an ornamental shrub with all the ornamental appeal of butterfly bush but lacking the propensity to spread from cultivation into surrounding natural areas.

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University of Arkansas Division of Agriculture

## Reduction of commercial nitrogen needs in corn by use of Austrian winter field peas as a nitrogen providing winter cover crop

#### Issue

The state of Arkansas produced nearly 440,000 acres of corn in 2008 with the acreage and crop value both expected to increase in 2009. Corn and corn related enterprises contributed nearly \$290 million to the Arkansas economy during 2008 so it must be considered a significant crop.

One of the major inputs for corn growers is the application of nitrogen fertilizer. In some instances, as much as 250 lbs. of N is required per acre. This application can require as much as 40% of the production budget. To help offset this, the use of winter field peas as a cover crop has shown the potential in our research to be able to replace as up to 100 of the 250 lbs. of the added nitrogen, or about 40%. If this 40% presented itself as realized savings, a corn producer should be able to add this to the bottom line of the production enterprise without realizing any decrease in grain yield or other increases in production costs. The results of two years data point to this possibility. In addition, commercial nitrogen is produced through the Haber process, a fossil fuel consuming,  $CO_2$  releasing endeavor.

#### Action

Corn was planted at the AES Experimental Farm in Fayetteville in 2005-2009, and on the farm of a private landowner near McCrory in 2008-2009. Each year the corn was preceded by drilled Austrian winter field peas. In 2006, 2007, 2008 and 2009 corn plots receiving no supplemental N (winter peas only) produced yields that were not significantly different from plots receiving as much as 200 lb. of N per acre. Said another way, plots receiving no N other than that provided by the winter peas, had corn yields that were equal to those plots that received 200 lb. of N per acre.

These data support our hypothesis that cover cropped peas can provide significant amounts of plant available N at much less cost than traditional sources while contributing to a possible reduction in greenhouse gas emissions.

#### Impact

The impact of this research would then be two-fold: 1) to bring about an increase in farm enterprise profitability without incurring additional expenditures, and 2) to supplement nearly 40% of the commercial nitrogen currently applied, thus reducing dependency on energy consuming processes used in nitrogen manufacture and to simultaneously reduce greenhouse gas emissions.

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#### Funding

Unrestricted Teaching and Research Fund-DBCAFLS; University of Arkansas Division of Agriculture

## Implementation of low impact development best management practices to remediate sediment from urban development

#### Issue

Northwest Arkansas is the sixth fastest growing Metropolitan Statistical Area in the U.S. The cities of Northwest Arkansas include Bentonville, Rogers, Springdale, Fayetteville, and Siloam Springs. These cities are located in both the Illinois and White River Watersheds. These watersheds receive wastewater discharge from most of the metropolitan communities in Northwest Arkansas and are a source of concern and conflict because of sediment and phosphorus loading to Oklahoma (Illinois River) and Beaver Lake (White River). Low density, automobile-oriented urban development—the prevalent model for new development—is generating sediment loads that are listed as pollutants of concern in both the Illinois and White Rivers. The impact of urbanization on NPS sediment loads occurs in two phases: 1) Direct loading during construction, and 2) Increased peak flows that erode stream banks, beds, and ground surfaces throughout the urban environment and within stream channels downstream of urban systems.

#### Action

In the effort to change the prevailing development model towards the integration of urban infrastructure and watershed planning, this project proposes to demonstrate Low Impact Development (LID) Best Management Practices (BMPs) in urban tributaries to the Illinois and White River Systems. In order to demonstrate a LID model for urban ecologies along urban tributaries to the Illinois and White River Systems we will perform the following tasks: 1) Develop municipal planning policies to protect streams from NPS impact from urban development, 2) Design a green neighborhood for Habitat for Humanity to demonstrate the impact and effectiveness of LID technologies in Fayetteville, Ark., 3) Measure the impact of LID technologies in reducing sediment loads to the White River in Northwest Arkansas, and 4) Develop and Implement Educational Workshops for LID technologies.

#### Impact

Fayetteville, Ark. sits on the watershed divide of the headwater streams of the Illinois and White River watersheds, and is rapidly urbanizing. Streams in the headwaters of these rivers provide critical ecological services for treating and removing pollution from the urban watershed. BMPs in ecological engineering alone, however, will not change nonpoint source problems as environmental planning and urban planning disciplines—each with their own BMPs and optimization tendencies—are conventionally practiced as parallel and separate fields. This project offers an integrated development model that embeds ecological metrics into urban planning templates, land-use policy, and infrastructure design. This project is only in its second year, and has already been recognized by four national and two state awards for excellence in design: 2009 American Architecture Award

2009 AIA Honor Award for Regional and Urban Design from the American Institute of Architects.

2009 Progressive Architecture Award from Architect magazine. 2008 American Society of Landscape Architects Honor Award in Planning and Analysis.

2008 Gunlogson National Design Competition in Biological Engineering – Third Place.

2008 Arkansas Institute of Architecture Citation Award. 2008 Arkansas Planning Association 2008 Achievement in Urban Development Award.

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#### Funding

U.S. Environmental Protection Agency through Arkansas Natural Resources Commission; University of Arkansas Division of Agriculture

# Native American students recruited for ecological projects

#### Issue

Underrepresented minorities are falling further behind in representation across disciplines in science and engineering. Experience with mentors in hands-on activities early in their undergraduate experience can be very helpful in increasing participation in these fields.

#### Action

The University of Arkansas is providing an integrated research experience for three cohort groups of 15 undergraduate students, each working with federally recognized Native American Tribal programs in Oklahoma, Kansas, Nebraska, and South Dakota. This experience integrates classroom and field research within each cohort with tribal management of ecological services. Cohorts are recruited through tribal educational programs from native-serving two-year colleges, four-year universities, tribal universities, and research universities.

#### Impact

During the first year of this project, nine undergraduate students worked with five faculty members to develop and implement research projects.

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National Science Foundation; University of Arkansas Division of Agriculture

## Demonstration of an algal turf scrubber for biofuels feedstock development

#### Issue

Alternative biofuel feedstocks are in high demand, especially as competition for alternative uses of traditional food and feed crops increases.

#### Action

The project objective is to operate a test bed algal turf scrubber (ATS) for one year. Algae will be harvested from the scrubber once per week over an annual cycle. Details of harvesting methods will be established by the Smithsonian Institute Center for Environmental Research (CER) and will be consistent with methods used at other project sites (Potomac River, Susquehanna River) so that direct comparisons of data can be made. Samples of algae from the ATS test bed will be dried and weighed to establish productivity rates. Some samples will be analyzed for nitrogen and phosphorus content, either once or twice per month. Other samples will be sent off for further analysis at the Smithsonian Institution and at Western Michigan University.

#### Impact

A demonstration scale algal turf scrubber was constructed in Springdale, Ark. and has operated for 10 months. Algal production efficiency and effectiveness is being evaluated.

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#### Funding

Smithsonian Institute Center for Environmental Research; University of Arkansas Division of Agriculture

# Monitoring of rivers for pesticides used in rice production

#### Issue

Pesticides aid in the production of food and fiber. However, there is also the potential for contamination of surface water. If environmentally harmful amounts of pesticides begin to appear in surface water, early awareness of the situation would make it easier to remedy.

#### Action

We are monitoring surface water at four locations each on the Cache, St. Francis, L'Anguille rivers and Lagrue Bayou every two weeks from the middle of April through August for pesticides used in rice production. These four rivers were chosen because they are small and are mostly in rice producing areas so there would be less dilution of any pesticide present from water from non-rice producing areas. Some pesticides have been found at low parts per billion (ppb) levels during the growing season. The results for the past seven years have been variable for some aspects, but consistent for others. Originally molinate (Ordram®) was one of the most frequently detected compounds, but the frequency declined and it is now not found. Now the most frequently detected compounds are quinclorac (Facet®) and clomazone (Command®). Concentrations are typically low (less than 10 ppb). In four of the last six years the highest concentration has been between 13 and 19 ppb, and in the other two years it was 28 ppb. Most detections are in June and July, when compounds are applied. Over the past seven years we have seen no trends of increasing detections, concentrations, or multiple compounds in a sample. We have now established a baseline of what is found and what to expect in year to year variation. Analyses in future years will allow us to see if there are differences, either up or down.

#### Impact

It is not unusual to detect low levels of pesticides in surface water in an agricultural area especially during the growing season, since pesticides need some water solubility to be effective. We have not observed any trends toward increasing frequency, amounts of pesticides, or multiple detections in the rivers at the sites sampled in previous years. These results indicate that production practices as they are now being done in the rice growing areas do not seem to be having an adverse effect on the surrounding water due to pesticide contamination.

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#### Funding

Arkansas Rice Research and Promotion Board; University of Arkansas Division of Agriculture

## A master plan for a part of the Evans Children Adventure Garden at Garvan Woodland Gardens

#### Issue

Themed gardens are an important part of most public gardens in the United States. There is an increasing interest among public gardens to include children's gardens in garden master plans with a goal of increasing garden attendance and broadening the appeal of public garden spaces to a younger segment of the population including families with children. Traditional children's gardens were modeled more on recreational playgrounds or outside classroom venues rather than on true garden environments often with very little green space or indeed plants. Educational outreach opportunities are often limited to classroom experiences with demonstrative plant or natural materials being containerized or gathered from various areas of the garden, but little actually growing in the children's garden itself. Garvan Gardens in Hot Springs Arkansas has received funding from the Bob and Sunny Evans family to help develop a children's garden utilizing traditional garden elements including stone, water, and plants. The design challenge has been to incorporate traditional garden elements such as plants, water, and stone with "child friendly" safe or high maintenance areas typically associated with recreational play structures or areas. Design and development criteria mandate the use of plants native to the Ouachita or Ozark Mountain region. Sustainable design and management practices are also a design criterion. A master plan incorporating sustainable design principles and native plants along with design elements and concepts unique to children's gardens is in the process of being developed though the work of a master's student.

#### Action

A site analysis of the site was conducted in the summer of 2009 along with consultations with Garvan Garden personnel concerning overall design concepts and space utilization. A literature search was conducted investigating current methodologies in children's garden design along with associated sustainable practices as they relate to children's themed gardens in public spaces. A list of suitable native plants has been collected and currently detailed planting plans are being developed.

#### Impact

The Evans Children Garden at Garvan Woodland Garden offers a unique opportunity to combine the latest information on effective children's garden spaces with a natural woodland setting complete with local elements including indigenous plants. The overall educational goal is to teach youth about plants native to Arkansas and woodland settings in an aesthetically pleasing environment that will attract families into a quality landscaped environment. The master plan will allow Garvan Garden to meet the goals of creating a meaningful children's garden using a sustainable management plan.

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#### Funding

University of Arkansas Division of Agriculture

## Use of co-products and by-products from the food industry to produce valued added products

#### Issue

With stringent regulations, the expansion of urban areas, and the depletion of natural resources, food processors face the challenge of creating industries that minimize waste, cut pollution, reduce energy consumption, and comply with or exceed regulations. The concern of an approaching exhaustion of petroleum, which has provided an inexpensive source of energy and raw materials for decades, has driven the interest for alternative sources of bio-based products and biofuels based on renewable sources. The creation of a bio-based economy will require the expansion of current crops and the addition of new crops that eventually will introduce vast amounts of coproducts into the market that will compete with the traditional by-products from food production. Therefore, it is critical to develop new applications for co-products and by-products from the food industry, especially from the protein sector.

#### Action

In response to the need of new applications for co-products and by-products from the food industry and specialized crops, researchers have been working on the depolymerization of protein co-products from different sources using green technologies. Enzymes and superheated water are currently used to hydrolyze protein co-products to different degrees of hydrolysis, which generate free amino acids and peptides with diverse functionalities.

#### Impact

The development of green processes, to produce protein hydrolyzates from co-products, will have in important impact in the replacement of less environmentally friendly practices, which are currently used, with methods that are sustainable in the long term. Protein hydrolyzates generated with green technologies using co-products from the food industry and specialized crops (e.g. energy crops) will then be used to develop new products and applications.

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#### Funding

University of Arkansas Division of Agriculture

## How carbon policies could affect Arkansas producers: A county level emissions and sequestration analysis

#### Issue

The U.S. House of Representatives passed the Waxman-Markey Bill (The American Clean Energy and Security Act, ACES, H.R. 2454) on June 26, 2009. While the bill addressed greenhouse gas (GHG) emissions and the cap-and-trade system to reduce climate change and build a clean energy economy, little research has been conducted on its impacts on the U.S. economy and specifically the agricultural sector in the U.S. and in Arkansas. While there is a small, and relatively unused, carbon market that exists now, if the Waxman- Markey bill passes the Senate, carbon is estimated to go from \$0.50 a ton to an estimated \$30 to \$40 per ton. Given the fact that agriculture is one of the few ways to sequester carbon to sell, and each crop sequesters a different amount of carbon, this could have major implications for cropping patterns. Little research has been conducted on how various carbon prices would affect producer revenue and cropping patterns in the U.S., and the literature is nearly void in Arkansas.

#### Action

A model was constructed to estimate the impact of the Waxman-Markey bill on agricultural producers in Arkansas. This model can estimate changes in cropping allocations as well as changes in producer revenue on a county level under the specifications laid out under the Waxman-Markey bill. This model has been developed using county and crop production specific information to offer county level and crop specific detail on carbon emission and sequestration. Therefore, the model is able to estimate crop specific carbon foot print (both emissions and sequestration by production practice and production location) to measure county crop farm income impacts of various GHG policies. The sequestration portion of the model took into account the soil portfolio in each county, the tillage practices, and harvest indices for each crop in each county. From this, an estimate of sequestered carbon per acre per crop per county could be obtained.

#### Impact

The emissions portion of the model gives policy makers estimates of the impacts of the Waxman-Markey bill and other potential GHG policies on Arkansas producers. The estimates also give commodity groups an idea of where they stand in terms of GHG emissions in comparisons to alternative crops. The results were presented to two commodity groups (Rice Federation and Cotton Incorporated) as invited seminars. The sequestration portion of the model sets forth a new methodology for measuring carbon emissions as well as providing policy makers the implications of carbon offset (sequestration) market. The models estimates have been used by commodity groups (Cotton Incorporated) to assess how a carbon offset market would affect cotton producers in Arkansas and around the country. The estimates also provide policy makers a snap-

shot of how various carbon offset prices will affect cropping patterns and resulting input and output prices.

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#### Funding

University of Arkansas Division of Agriculture; Cotton Incorporated

## The use of dissolved oxygen technology to enhance the treatment of organic wastewater

#### Issue

An indicator of the societal impact of wastewater treatment is that the U.S. market for bioremediation and wastewater treatment was \$9 billion in 2002. The predominant treatment of organic wastewater is biological where bacteria digest organic matter through their respiration cycle. Efficient and effective biological wastewater treatment occurs under aerobic conditions (in the presence of oxygen) and therefore requires that oxygen be delivered to the water to meet the biochemical demands of the bacteria. If sufficient rates of oxygen delivery are not provided, the rate of treatment is greatly reduced and undesirable byproducts (such as odors) are produced. Another important tool for removing pollutants from water is the application of dissolved ozone. Ozone is a powerful oxidant that can kill bacteria, spores, cysts, and viruses. Ozone can also be used to oxidize chemical to less harmful states. The use of ozone is becoming more and more important as the byproducts from chlorine disinfection (a competing technology) are becoming regulated as more is learned about their harmful effects on humans. Ozone also has potential as a technique for removing drug and antibiotic residuals from wastewater streams being released from hospitals. This treatment can reduce the occurrence of drug resistant strains of bacteria that form because of exposure to residuals in the environment. Specific problems being addressed in this work include: stream restoration, animal waste lagoon odor prevention, removal of antibiotic residuals from hospital wastewater, drinking water treatment, municipal wastewater treatment, aquaculture, and food processing wastewater treatment

#### Action

The device developed utilizes a new technology that allows for the efficient oxygenation and ozonation of a wide variety of water bodies, both natural and manmade. This new technology is much less expensive to operate than existing technology for several key applications. Operating cost savings of 80% have been demonstrated on-site at commercial operations. The patented and patent pending technology delivers a stream of water that has been supersaturated with a gas (such as oxygen, air or ozone). Once this supersaturated stream is released to a

water body, the dissolved gas is blended with environmental waters and does not exit solution.

#### Impact

The intellectual property for this invention is owned by the University of Arkansas and licensed to BlueinGreen, LLC, a start-up company created as a partnership between the inventors, U of A, and a private Fayetteville-based company, Virtual Incubation, Inc.

The use of the Supersaturated Dissolved Oxygen Injector (SDOX) technology for a variety of applications has been studied in detail. Commercial demonstrations of the technology have been conducted at Noland Wastewater Treatment Plant in Fayetteville, Ark., Rogers Pollution Control Facility, Lake Brittany in Bella Vista, Ark., Norfork National Trout Hatchery at Norfork Lake, Ark. Operating cost savings of 80% have been achieved at the commercial scale. The first commercial sale of the unit was made to the City of Fayetteville in 2007. Additional equipment is in operation at facilities in Camano Island, Wash.; Austin, Texas and a unit is currently being constructed and installed in Lake Thunderbird near Norman, Okla. Since the SDOX delivers oxygen in the dissolved state, a substantial cost savings is realized because none of the oxygen is lost due to bubbling out of the top of the water column as is seen with fine-bubble diffusers that deliver oxygen in the gaseous state. The impact of this result is that wastewater treatment facilities may be able to increase their processing capacity without increasing costs or adding significant additional infrastructure. The SDOX may also be able to replace existing technology and provide substantial operating cost savings to wastewater treatment plants.

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National Science Foundation, National Institutes of Health, Beaver Water District. Tulsa Water Utilities; University of Arkansas Division of Agriculture; Private Investors U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service

## Agroforests for biomass and ecosystem services

#### Issue

Global climate issues and the need for increased domestic energy have increased the demand for renewable energy development in the United States. In Arkansas, solar and wind power will not be adequate to meet the standards being set by the federal government and so there is increasing demand for biomass as a bioenergy resource. Criteria for an efficient biomass production system includes high levels of productivity, low levels of inputs, especially water and fertilizer, the use of low-productivity lands so as to avoid competition with food production, and the creation of ecosystem services that promote carbon sequestration and enhance biological diversity.

#### Action

Experimental agroforest systems of cottonwood and switchgrass, both high productive biomass crops, have been established in 2009 on marginal agricultural soils on three locations in the Lower Mississippi River Alluvial Valley. These systems will be monitored for biomass production, water quality, carbon sequestration, use and retention of fertilizers, and wildlife habitat use.

#### Impact

This is a long-term study that will provide farmers and landowners an option of producing biomass while enhancing ecosystem services such as carbon sequestration and biological diversity on agricultural lands that provide low net economic returns under traditional row crop management. Emerging markets for carbon sequestration and continued biodiversity easement programs will enhance farm and forest returns from these marginal lands.

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#### Funding

U.S. Dept. of Transportation, Sun Grant Initiative – South Central; U.S. Department of Agriculture, Sustainable Agriculture Research and Education; University of Arkansas Division of Agriculture, Arkansas Forest Resources Center

## Selection and placement of best management practices used to reduce total phosphorous runoff

#### Issue

An increased loss of agricultural nutrients is a growing concern for water quality in Arkansas. Several studies have shown that best management practices (BMPs) are effective in controlling nutrient runoff. Methodologies and tools that help to find solutions for incorporation into water management plans are needed that take into consideration BMP selection, placement and affordability.

#### Action

The objective of this study was to provide policy-makers with quantitative information about the costs and water quality benefit trade-offs associated with different watershed water management strategies for the Lincoln Lake Watershed. A genetic algorithm (GA) model was used to identify a mix of BMP practices that reduces pollution in a cost effective manner. Ninety-five scenarios were created using combinations of BMPs. Practices were grouped into pasture management, buffer zones and poultry litter application practices. The GA identified a variety of solution sets, but most often included BMPs with buffer zones and low litter application rates as those most cost effective in reducing total phosphorus in the watershed. The presence of alternative solutions allows decision makers to weigh tradeoffs between total phosphorus load reduction and costs.

#### Impact

The GA optimization model provides policy makers with a number of alternatives that can help reach a water quality target at different levels of costs. This allows policy makers to choose watershed level management strategies that are most appropriate for the land use and help sustain the economic base of the watershed.

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#### Funding

USDA CSREES; University of Arkansas Division of Agriculture

# Broad-host-range plasmids in treated wastewater effluent and receiving streams

#### Issue

Broad-host-range (BHR) plasmids often carry genes for antibiotic resistance. If BHR plasmids are not removed in wastewater treatment, they can enter streams receiving wastewater treatment plant (WWTP) effluent. This is of concern for dissemination of antibiotic resistance because BHR plasmids, as the name implies, can be maintained and transferred in a wide range of bacteria.

#### Action

Mud Creek in Fayetteville, Ark., was receiving WWTP effluent. The presence of antibiotics at low levels, and antibiotic resistant bacteria, has been detected in Mud Creek. Therefore, Mud Creek was sampled for BHR plasmids upstream and downstream of effluent input and at the point of effluent input into the stream. Detection of gene fragments of four plasmid groups was employed to determine if DNA extracted from water samples indicated that BHR plasmids were present. To determine if results in Mud Creek were similar to other streams receiving WWTP effluent, Spring Creek in Springdale was sampled.

#### Impact

One plasmid group (Inc P) was detected consistently in the effluent and downstream Mud Creek water samples, but not upstream of the WWTP effluent input. A second plasmid group (Inc A/C) was detected at all sites and the final two

groups (Inc N and Inc W) were not detected in any water samples in Mud Creek. Results for two groups (Inc P and Inc A/C) were consistent across streams; however, the two groups not detected in water from Mud Creek were detected in effluent and downstream water, but not upstream, in Spring Creek. Results suggest that WWTP effluent is introducing BHR plasmids into streams, and this introduction is not isolated to one stream. Because BHR plasmids are frequently associated with antibiotic resistance genes and have a broad range of potential bacterial hosts, the implications for dissemination of antibiotic resistance deserve further investigation.

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#### Funding

USGS/Water Resources Research Institute; Sigma Xi Grants-in-Aid of Research; University of Arkansas Division of Agriculture

# Soil responses to fertilizer and ground cover management in an organic orchard

#### Issue

Apple producers in the Southern U.S. need more research on management practices in organic systems, especially in regards to organic fertilizers and management of ground covers to maintain a sustainable system and to provide proper tree nutrition. As part of the system, soil responses need to be investigated simultaneously with tree responses.

#### Action

Land at the Agricultural Experiment Station in Fayetteville was used to establish an organic orchard. One of the objectives of this long-term study is to determine whether the interactions of organic nutrient sources and ground cover management improve soil biological activity and nutrient availability in concert or in competition with tree growth and nutrient uptake. An orchard was established to study the following treatments, including four ground covers, compost, wood chips, shredded paper, and mow-and-blow, and three nutrient sources, a control with only ground cover supplying nutrients, composted poultry litter, and a poultry litter based organic commercial fertilizer. Soils were sampled at the 0-10 cm and 10-30 cm depths in the spring before and after treatment applications.

#### Impact

Ground covers had more significant effects on soil properties measured than fertilizers; although, fertilizer applications did result in some increases in dissolved organic N in the surface soil depth. Microbial biomass and enzyme activities appeared to benefit from mow-and-blow, while dissolved N pools frequently were greatest under compost. Tree growth and canopy development benefitted in compost and wood chips, while trees with shredded paper and mow-and-blow treatments had significantly fewer flowers and were too small to produce a crop in the first cropping year. Results show that as an orchard is being established, management practices affect soil health differently than tree growth. The effects on soil health may not be completely manifest in the trees for several years as the system stabilizes and trees achieve their final size.

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#### Funding

USDA - Southern Sustainable Agriculture Research and Education Program; USDA Integrated Organic Program; University of Arkansas Division of Agriculture

# Proper collection and disposal of agricultural pesticides in Arkansas

#### Issue

Old, abandoned, or unwanted agricultural pesticides pose a significant risk to human health and the environment. If the chemicals are improperly stored or the containers degrade and begin leaking, pesticides can end up in ground and surface water or released into the environment. Tornadoes, floods, fires, etc. can also lead to environmental contamination from pesticides and the potential for human exposure. The problem is exacerbated by the fact that many of the old pesticides are more toxic and environmentally persistent relative to the current pesticides in use.

#### Action

The University of Arkansas Division of Agriculture first became involved with developing a pesticide collection program for unwanted pesticides in 1992. The Conway County Cooperative Extension Service initiated a collection day plan for their county. The county extension staff worked with the various stakeholders in the county to develop the program and hire a licensed hazardous waste contractor. Over 1,000 pounds and 200 gallons of pesticides were collected in the county on December 5, 1992.

In 1999 the Arkansas Legislature enacted "The Abandoned Agricultural Pesticide Disposal Act". The legislation initiated a program for the collection of unwanted or abandoned pesticides for proper disposal. The program applied to private farmers, growers, and producers but not commercial operations. The program is funded by a registration fee increase for pesticide registrants and there is no cost for the farmers/producers. A licensed hazardous waste contractor handles all of the over-packing, transportation, and disposal of the collected pesticides to ensure safety to participants and the environment. The legislation provides for an ongoing collection program for the entire state so farmers will always have a reliable means of pesticide disposal.

The University's Pesticide Education Specialist represents the Cooperative Extension Service as a member of the Advisory Board that plans, oversees, and evaluates the program. The Cooperative Extension Service county agents have taken a major role in developing the protocol, establishing stakeholder committees in each county, making local arrangements, advertising the program, and handling questions and concerns at the county level.

#### Impact

To date, collection programs have been conducted in 34 counties and over 677,000 pounds of old, unwanted, or abandoned pesticides have been collected and disposed of properly. The initial collections were done in the Delta region of the state because of the historic, large scale farming operations in this region. The program is now attempting 10 collections per year (10 were conducted in 2009) primarily in the spring or fall to avoid the busy growing season for farmers. A significant portion of the collected pesticides have been highly toxic arsenical insecticides that are no longer labeled for use because of environmental and human safety problems. The collection and proper disposal of all the collected pesticides has ensured that these chemicals will not endanger the citizens of Arkansas nor impair our environment.

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Arkansas State Plant Board; Arkansas Farm Bureau; Soil and Water Conservation Commission; Arkansas Department of Environmental Quality; Natural Resources Conservation Service

#### Funding

Pesticide registration fees from pesticide registrants. Matching grants from Natural Resources Conservation Service Arkansas Department of Environmental Quality; University of Arkansas Division of Agriculture

# Diversity and distribution of Arkansas Siricidae and their natural enemies

#### Issue

Invasive species continue to arrive at an alarming rate and their impacts can be devastating to North American forests. Arkansas has a significant portion of its total forest resource (7.4 million ha) in pines (2.2 million ha). Shortleaf (Pinus echinata Mill.) and loblolly pine (P. taeda L.) are both native to Arkansas and can be found in forests across the three physiographic regions of the state. The European wood wasp, Sirex noctilio F., a devastating pest in pine plantations planted in the southern hemisphere, was found breeding in pines in New York state. It has not yet been detected in Arkansas, but both existing host pines and climate models suggest that if it is introduced it will successfully survive and reproduce. Knowledge of life histories and naturally occurring biological control agents of related siricid species will provide background information to assist in survey and detection, eradication, and- if necessary-management of this exotic wood wasp species.

#### Action

We initiated a research project in 2009 to investigate the life

histories of related siricid species in order to provide background information to assist in survey and detection, eradication, and management of this exotic wood wasp species if it is detected in Arkansas.

In North America, 17 species of siricid wood wasps colonize *Pinus* spp. as a host resource. Two species of *Sirex* (*S. edwardsii* Brullé, and *S. nigricornis* F.) are commonly represented in the University of Arkansas Arthropod Museum collection, but little comprehensive research has been conducted on their natural enemy complex, relative abundance or diversity in forests. Both of these species have been recorded from most southern states, including Arkansas. Because our native species of wood wasps—which are not pests—have insects and nematodes that may serve as naturally occurring biological control agents for *Sirex noctilio*, the more information we have about these beneficial species prior to the arrival of *S. noctilio*, the more prepared we will be for a rapid response when the exotic wood wasp is found.

With the cooperation of private landowners, USDA Forest Service, and Army Corps of Engineers, we have located field research sites throughout Arkansas. At those sites, we have erected traps to catch adult siricids and to monitor the species composition and abundance of trapped wood wasps. We also have created 'trap trees' in which we anticipate native siricids will attempt to reproduce. These trees will be returned to our laboratory and dissected to collect and identify our native species and their natural enemies

#### Impact

The research that we have initiated will allow us to discover new knowledge on the biology, distribution and life histories of native and exotic siricids and their beneficial natural enemies, both parasitoids and nematodes. We should be able to document flight periods of adult siricids, and use this information in conjunction with rearing studies to more completely define the life histories of the wood wasps in Arkansas. We should learn which species are currently found, and whether they occur in all of the pine growing regions of the state. We should discover whether loblolly and shortleaf pine host different complexes of wood wasps, or whether the life histories or natural enemy complexes differ in either pine species. As a collateral benefit, our research may yield new information on the host range of another exotic wood wasp, the Asian horntail, Eriotremex formosanus, which has spread throughout the southern U.S. This wood wasp is normally considered to attack deciduous trees, but it has been collected frequently near or at pines in central Louisiana and it may represent another threat to pines in Arkansas.

Armed with the knowledge we expect to obtain, we will be better prepared to detect and manage the invasive *Sirex noctilio* when it arrives in Arkansas.

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### Funding

USDA Forest Service, Southern Research Station, and Northern Research Station; University of Arkansas Division of Agriculture

# Molecular phylogenetics of an invasive ant species, the Rasberry crazy ant

#### Issue

The recent introduction of an invasive ant species in the genus Paratrechina to Texas, has spread throughout Texas. The identity of this ant species is unknown, despite morphometric analyses. In 2002 it was dubbed "the Rasberry crazy ant" by the media after its initial discoverer, Tom Rasberry. Since its introduction, the Rasberry crazy ant has created numerous ecological and economic concerns. Anecdotal reports have indicated that this ant has caused electrical short-circuits and other problems, including air conditioning units, chemical-pipe valve computers, sewage-lift pump stations and phone lines. Attempts to control this ant by the untrained public have been costly and ineffective. Much of the effort has been hampered by the confusion regarding the identification of the ant species, as it is nearly identical to a native species, Paratrechina pubens. Due to the taxonomic difficulties in identifying the Rasberry crazy ant, we conducted a molecular genetic phylogenetic analysis to determine the identity of this invasive ant as well as the potential origin of the species to the United States.

#### Action

A total of nine species of ants of the genus *Paratrechina* from North, Central and South America were obtained from collaborators in Texas and Florida. DNA was extracted from the ants and then a portion of the mitochondrial DNA genome was amplified using PCR. Analyses of mitochondrial DNA sequences of *Paratrechina* species revealed several distinct relationships. Results indicated that the Rasberry crazy ant was not identical to any of the other species used in the genetic study, and was different from *P. pubens* from Florida.

#### Impact

It is clear that the Rasberry crazy ant is not a North American species and is exotic to the United States. A more comprehensive sampling throughout the Caribbean and South America for the Rasberry crazy ant is required to assist in more accurately identifying the point of origin for these introductions to the United States. These analyses also heighten awareness of the difficulties in establishing correct ant identifications for *Paratrechina* ants. It is imperative that this understudied group be revised from both morphometric and molecular levels. The inclusion of other South American and Caribbean populations may help to reveal possible points-of-origin of Rasberry crazy ant into the U.S.

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### Funding

University of Arkansas Division of Agriculture; Center for Urban and Structural Entomology, Texas A&M University

## Temporal variation of a small mammal community at a wetland restoration site in southeast Arkansas

#### Issue

Historically, the Lower Mississippi Alluvial Valley in Arkansas was composed of wetlands containing bottomland hardwoods. Approximately 85,000 ha of forested wetlands were converted for agriculture in Arkansas from the mid-1970s to the mid-1980s. Many farmers are now trying to convert these areas back to their original condition because of declines in their agricultural value. Wetland restoration practices in the Arkansas Delta influence hydrological processes that control the life processes of animals living in wetland habitats. Small mammals serve many important ecological roles in wetland ecosystems. They serve as a primary prey base for several predators, they aid in plant nutrient procurement by dispersing fungal spores that form root-inhabiting ectomycorrhizae, and they can impact the regeneration of plants through consumption and dispersal of seeds. Our objective was to assess temporal variation in numbers of individuals and species of small mammals on a wetland restoration site.

#### Action

The study was conducted on the Bob White Memorial Wetlands Research and Teaching Station. Previously collected small mammal data were used from trapping sessions conducted monthly from February through October on four trapping grids located in a wetland restoration area. The numbers and proportions of individuals captured varied monthly by species. Peaks in abundance of small-mammal species did not occur simultaneously. Monthly variations in the small-mammal community at our study site were likely due to changes in amount of water coupled with species interactions. For example, marsh rice rat captures were greatest in February and hispid cotton rat captures peaked in July. Increased captures of marsh rice rats in February were likely due to the amount of water on the site during this period, and because this species is semi aquatic. The subsequent decline in captures of marsh rice rats may be attributable to the decline in water and the proliferation of hispid cotton rats.

#### Impact

Documentation of monthly fluctuations in the composition and numbers of this small-mammal community provides a basis by which to evaluate future restoration activities. Management practices that influence water levels and duration will likely influence small-mammal community characteristics. An increased understanding of these relationships will aid natural resource managers in restoring wetlands to improve ecosystem services.

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#### Funding

University of Arkansas Division of Agriculture, Arkansas Forest Resources Center; University of Arkansas at Monticello; Bob White Memorial Foundation

# Red-cockaded woodpecker selection of foraging trees

#### Issue

Foraging habitat guidelines for the federally endangered red-cockaded woodpecker (RCW) established in the U.S. Fish and Wildlife Service RCW recovery plan were derived from research primarily conducted on public lands located within the historic range of the longleaf pine. Because RCW populations also exist on private, commercially-managed forests, we investigated foraging activities of RCWs on commercial forests beyond the historic range of longleaf pine in southern Arkansas and northern Louisiana. Specifically, we evaluated previously collected data related to RCW patterns of foraging habitat use and resource selection by comparing the characteristics of used pine trees and paired random pine trees.

#### Action

The study was conducted in the Gulf Coastal Plain physiographic region of southern Arkansas and northern Louisiana. A data set representing 10 months of observations of 21 RCW groups foraging in four Arkansas counties and four Louisiana parishes was evaluated. Characteristics of trees selected by RCWs were compared to randomly selected trees. Our research indicated that diameter at breast height (DBH), age, lower bole height, tree height, lower bole bark surface area, crown bole bark surface area, and total bole bark surface area were greater for pine trees used for foraging activities by RCWs than random pine trees. Further model development identified the most important factors in RCWs selecting trees to forage on were DBH, tree height, and lower bole bark surface area.

#### Impact

Guidelines established by the U.S. FWS emphasize the importance of pine tree DBH and age in RCW foraging habitats. Specifically, those guidelines require pine stands that are >30 years old and >25.4 cm DBH without any requirements for tree height. However, our results suggest tree age was not as important as DBH, tree height, and bark surface area to foraging RCWs. We are unaware of any other research that has examined the importance of bark surface area to foraging RCWs. This information will aid natural resource managers in developing effective forest management schemes in concert with effective RCW protection.

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Cooperators Louisiana Tech University

#### Funding

University of Arkansas Division of Agriculture, Arkansas Forest Resources Center; National Council for Air and Stream Improvement

# Comparative financial characteristics of U.S. farms by type, 2005

#### Issue

Information on comparable financial characteristics among investment options is highly important to investor and operator decision-making. This aspect becomes even more critical for farm businesses, where inherent and sizable risks are unavoidable. In particular, there is scarcity of information on comparative performance of U.S. crop and livestock businesses at the whole farm level.

#### Action

The study focuses on the financial characteristics of different types of crop and livestock farms in the United States for 2005. Data from USDA's comprehensive, national Agricultural Resource Management Survey (ARMS) are used to analyze the mean financial characteristics of eighteen different farm types based on ARMS classification. The eighteen farm types are: poultry, beef cattle, hogs, dairy, general livestock, general cash grain, wheat, corn, soybean, grain sorghum, rice, tobacco, cotton, peanut, general crop, fruits and tree nuts, vegetables, and nursery and greenhouse. Non-family farms and retirement farms are excluded from the analysis to make the results more closely represent typical U.S. farm commercial businesses that operate on a continuing basis. For each farm type, eleven different financial characteristics from farm income and farm balance sheet variables are computed. They are gross cash income, government payments, net cash farm income, net farm income, farm assets, farm liabilities, farm equity, current ratio, debt to asset ratio, asset turnover ratio, and operating expense ratio.

The analysis first ranks all farm types for each financial characteristic according to their mean values. Then all possible two-way comparisons of the means of a given characteristic for each different pair of farm business types are computed, statistically significant differences are presented, and the results are discussed. Analysis is limited to the total farm level because allocation of inputs on a per unit basis is difficult for many farm types (e.g., rice) because most farms have multiple farm products (e.g., rice and soybeans).

#### Impact

The study contributes to the relatively scarce literature on farm financial characteristics and provides a general indication of the relative size, profitability, liquidity, solvency, and financial efficiency of different types of U.S. crop and livestock businesses at the farm level. While it may not be appropriate to take the computed absolute dollar figures from the income statement and balance sheet of the different farms at their face values, using the relative relationships, i.e., ratios, as indications are deemed reasonable. Information on the relative financial characteristics of the different crop and livestock farm businesses could serve as important decision inputs for farm producers. Also, the information could be used by credit providers, farm related businesses, and policy makers to have a better understanding of the relative financial strengths and weaknesses of different farm types. However, an important caveat is that the results are based on only one year of data and, hence, merit further study. While this one-year analysis contributes to the better understanding of different farms' relative financial characteristics, it is simply a snapshot. The results could vary across years. Therefore, including more years of observations would certainly make the analysis more general. At the very least, this study provides an initial analytical framework that can be modified, expanded, and improved.

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This is a national, multi-institutional project that relies on the collaboration and cooperation of the USDA Economic Research Service, National Agricultural Statistics Service and Arkansas Agricultural Statistics Service

#### Funding

Arkansas Rice Research and Promotion Board project "Economic Analysis of Arkansas Farms"; USDA Cooperative State Research, Extension, and Education Service project "Farm Service Agency Direct Farm Loan Program Effectiveness Study" award number 2004-39528-14476; University of Arkansas Division of Agriculture

## The Hope and Power Personal Finance Program: Empowering women who have experienced domestic violence

#### Issue

It is estimated that around 4 million women will experience battering in an intimate relationship, and over their lifetime, around 25% of all women will experience abuse (Postmus, 2000). While there is a great deal of research that focuses on the relationship dynamics of domestic violence, very little research has been conducted on assisting women of domestic violence with financial literacy. Yet, women's financial dependency and lack of control over finances are key issues contributing to domestic violence. The goal of this research is to evaluate whether or not the Hope and Power Program, developed by the National Coalition against Domestic Violence, will help women increase their financial literacy so that women can feel more confident in becoming financially independent from their abusers.
#### Action

This gap in the research was identified by Dawna Beeler (M.S. Candidate) in the course of reviewing literature for her master's thesis project. The goal of the study has been to find out if the Hope and Power curriculum works, and to what extent it may help women deal with personal finances after leaving their abusers. The research project involved Dawna Beeler being trained in the Hope and Power Program, teaching the curriculum to clients at the Peace at Home Family Shelter in Fayetteville, and conducting a pre-test/post-test evaluation and three month follow-up with clients. Preliminary analysis of the pre- and post-test data suggests a significant increase in women's knowledge of personal finances after the curriculum is taught. Further analyses of the data are in progress.

#### Impact

Preliminary analyses of the data suggest that the Hope and Power Program does help to increase the women's knowledge of personal finances. The children of the women will benefit by their mothers gaining more financial knowledge in order to become more financially independent and improve their lives.

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#### Funding

\$8,850 from the Women's Giving Circle, University of Arkansas, University Development, University House; University of Arkansas Division of Agriculture

## Biological engineering students design simple prosthetics for manufacture and use in the developing world

#### Issue

In developing countries, there are many people who have suffered amputation of limbs due to trauma (from war, natural disaters and motor vehicle accidents) along with complications from diabetes and other vascular diseases. Physicians in many countries are less able to save threatened limbs due to poor emergency health care and limited follow-up care in the home. Prosthetic limbs typically used in the U.S. are much too expensive for amputees in developing countries. Most patients either suffer without an artificial limb, or they rely on donated prosthetics (e.g., discarded by patients in the U.S.) imported to the country by international medical missions. In order for the medical systems in developing countries to meet needs of their patients in a sustainable way, there is a need for prosthetic components which can be manufactured locally in developing countries.

#### Action

Since 2006, UA biological engineering senior design teams have focused on the design of low-cost prosthetic devices for use in developing countries. One team designed a single-axis prosthetic knee using the material Delrin and stainless steel bolts. Another team designed and implemented a fatigue testing machine capable of applying repetitive loading to prosthetic components to verify fatigue strength. Three successive teams have worked on simple designs for a low-cost prosthetic foot. Students did the research, considered multiple alternatives, and used engineering methods to optimize the best solutions. The two semester course sequence allowed students to build and test prototypes of their designs. Students and faculty have twice presented ideas to a prosthetic clinic in the Dominican Republic. The students also get feedback and suggestions from a local prosthetist and are working with the international medical group Physicians for Peace.

#### Impact

Biological engineering students are learning to incorporate biology and engineering to solve problems in the medical field. Prototypes designed, fabricated and tested by student design teams in their senior design course provide evidence that graduates of the program will make contributions to improve medicine, health and quality of life as professional engineers. Students in Arkansas--who have an interest in engineering, biology, and serving people--have an accredited engineering program at the UA that will help them to develop into important players in the world-wide health care system. Graduates can go on to medical school, do graduate work in biomedical engineering or seek industry jobs at the bachelor's level.

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#### Funding

College of Engineering University of Arkansas Division of Agriculture, Dale Bumpers College of Agricultural, Food and Life Sciences

## The impact of demographic dynamics on the social and environmental dimensions of rural areas

#### Issue

Rural communities are experiencing substantial change as a direct consequence of demographic dynamics such as population growth and decline as well as changes in age structure and migration-induced ethnic diversification. These changes, in turn, hold the potential for altering the social and environmental conditions in the local areas. However, given the nature of the changes in rural areas (particularly the case of the rapid emergence of rural communities becoming new destinations for Latino migrants), the magnitude and impacts of the changes on the social and environmental dimensions of these rural areas are not well understood. Rural leaders, policy makers and planners have a clear need for timely demographic and sociological data and information that provide insight into these changes.

#### Action

Research is being conducted to better understand the characteristics of migrants into rural areas of Arkansas and the U.S. as well as assessing the social and demographic antecedents of land cover change. To better understand whether there are differences between rural and urban migrants, researchers obtained data that document social and economic characteristics of the migrants including such things as origin, educational levels, language capabilities and legal status. Empirical models show a clearly discernable residential sorting taking place internal to the current migration stream from Mexico (and likely Meso America). This sorting is between rural and urban destinations with those migrants with less human capital (education, etc.) choosing rural destinations. Additionally, working with Cooperative Extension Service colleagues, research funded through the National Research Initiative within the USDA is currently underway that is designed to provide insight into barriers to entrepreneurship among recent Latino immigrants. A related project is underway to assess the demographic, social, and geophysical antecedents to land cover change on areas immediate adjacent to the boundaries of the Buffalo National River in Northern Arkansas. Land cover change models using demographic characteristics have been operationalized. These empirical models examine different modalities of land cover change as well as different social, environmental, and technological dimensions of underlying human-landscape interactions. An analytical framework has been developed that can be applied in other areas, providing empirical examination of local and regional proximate determinants of land cover change.

#### Impact

Research on the broader context of Latin American migration patterns in rural areas has demonstrated a "rural brain gain" or the addition of human capital with in-migration. Continued analysis is underway to understand how the human capital gained through in-migration interacts with the longstanding problem of young people leaving rural communities, the so-called "rural brain drain." Our research indicates the presence of untapped human resources in many rural communities. This newly formed reservoir of human capital holds the potential to serve as catalyst for the revitalization of rural communities that are experiencing economic decline. The project has also served to heighten awareness of the unique role Hispanics are playing in rural communities. The project results have been presented in professional venues that allow recognition of the spatial context of efforts by leaders (at all levels of government) when grappling with migration policy in the United States. The recognition that rural areas have limited resources compared to urban areas for assisting in the adaptation and assimilation of new residents is crucial. A key policy related product is the articulation of the importance of the explicit recognition of the unique circumstance of rural areas in the United States. Understanding the stresses placed on rural communities in terms of educational institutions, social services, governmental interactions, language and cultural barriers, and the efforts toward workforce training and development should be a major element in any migration policy action.

Outcomes from the environmental sociological research have shed light on the important differences in the demographic and social processes associated with different modalities of land cover change. This information is particularly important for policy makers and land managers and is being made available through peer-reviewed publications and professional presentations. Public land boundaries are found to operate as ecological switches but the induced behavior differs by type of public land and type of land cover change under examination. For development changes, national park lands seem to be increasingly isolated while national forest lands are experiencing increasing fragmentation along the boundaries. When deforestation is examined, transportation networks play a far more significant role than do population measures. Reforestation is found to provide evidence of the study area in the north central portion of the state to be undergoing the forest transition process. Understanding differences in the processes associated with different modes of land cover change enables planners and managers to anticipate more accurately potential problems.

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#### Funding

USDA-NRI; University of Arkansas Division of Agriculture

### Engine performance, efficiency and nitrogen oxide emissions when fueled with petroleum diesel vs. a B20 blend

#### Issue

Given price volatility and concerns about the long-term sustainability of petroleum diesel fuels, there is renewed interest in fueling compression-ignition (diesel) engines with petroleum-biofuel blends. Research is needed to determine if engines fueled with these blends differ in performance, fuel efficiency or emissions of oxides.

#### Action

Division of Agriculture researchers, University of Arkansas Facilities Management personnel, and the Arkansas Soybean Promotion Board cooperated in a two-year "in-use" study comparing the fuel efficiency (h/L), engine wear, and  $NO_x$  emissions (ppm) of eight Kubota RTV900 utility vehicles fueled with B20 (a blend of 20% biodiesel and 80% petroleum diesel) and eight vehicles fueled with D2 (No. 2 ULSD petroleum diesel). A separate laboratory "dynamometer study" was also completed comparing performance (power and torque), specific fuel consumption (kg/kWh) and specific  $NO_x$  emissions (ppm/kW) of the Kubota D902-E3B engine used in the Kubota RTV900 vehicles when fueled with B20 and D2. The utility vehicles in the in-use study were used by the Facilities Management grounds department at the University of Arkansas, primarily for transporting workers and grounds keeping equipment. Hours of use and fuel consumption were monitored via vehicle log books. Hours of use for vehicles fueled with D2 and B20 were approximately 540 hrs and 432 hrs, respectively. There were no significant (p > 0.05) differences in fuel efficiency, lubricating oil wear metals, or corrected NO<sub>x</sub> emissions between vehicles fueled with B20 or D2. For laboratory testing, an identical Kubota D902-E3B engine was mounted on a stationary stand and tested with both B20 and D2. In the laboratory dynamometer study, no significant differences were found in power (kW), torque (Nm), or specific fuel consumption (kg/kwh) when fueling the Kubota D902-E3B engine with D2 or B20. NO<sub>x</sub> emissions were found to be significantly lower when fueling with B20 as compared to D2. The tests showed no significant (p > 0.05) differences in engine power, torque, or fuel efficiency when fueling with D2 or B20. For the in-use test, no significant difference was found in NO<sub>v</sub> emissions when fueling with D2 or B20; however, during laboratory dynamometer tests, the engine produced significantly (p < 0.05) lower specific NO<sub>x</sub> emissions when fueled with B20.

#### Impact

This study provides both real-world and controlled laboratory data on engine performance, efficiency, and  $NO_x$  emissions for Kubota RTV900 utility vehicles fueled with D2 and B20 fuels. Such information is important in assessing the economic and environmental consequences of biofuel use.

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#### Funding

Arkansas Soybean Promotion Board; FutureFuel Chemical Co.; University of Arkansas Division of Agriculture, Arkansas Agricultural Experiment Station

# Specific impact on rural communities of changing demographics and challenges associated with aging

#### Issue

As people advance into old age, they are increasingly likely to experience challenges to their well-being. The challenges represent important costs to older persons, their families, and their communities. Moreover, the youngest members of the so-called Baby-Boomer Generation will begin to reach the age of 65 in the year 2011. This will represent the beginning of what is expected to be a rapid aging of the population. In fact, it is expected that the proportion of the population aged 65 years old and older will nearly double to 20.4% by the year 2030. At the same time, there may be no demographic trend in the United States that has garnered more attention from family researchers than the rise in divorce rates and accompanying rises in blended and stepfamilies. These demographic trends point to challenges in policies that impact the physical, monetary, and psychological well-being of older persons. It may also be that the social costs associated with aging may be felt to a greater degree in rural than in non-rural communities. Specifically, compared to non-rural communities, rural communities may be experiencing more rapid population aging and older persons may have more difficulty in accessing health care, including assistance with psychological needs. To address these challenges, research was undertaken to understand the how the broad demographic changes expected to take place in the United States may have an impact specifically on rural communities.

#### Action

To more fully understand how rurality may be related to challenges associated with aging, data from the nationally representative Health and Retirement Study (HRS) were examined. These studies examined aging issues associated with aging that included monetary transfers between older persons and their adult children, depressive symptoms experienced by older persons, and familial and non-familial relationships of older persons. Examples of findings include the following. First, monetary exchanges between stepparents and stepchildren were less frequent than between parents and children, although the stepfamily intergenerational support remained substantive for individual well-being. Older rural persons, as compared to their non-rural counterparts, were likely to experience more depressive symptoms. At the same time, the study found that rural persons perceived that they had, compared to non-rural older persons, larger numbers of close friends, greater ability to rely on family members and more time with family members, including adult children. These relationships were buffers against depressive symptoms and likely represent a source of resiliency for older persons.

#### Impact

These studies highlight the important role of close personal relationships for the health and well-being of all older persons and suggest that these relationships may be a source of resilience for rural older persons. Family researchers are continuing to examine how increased diversity in family structure as a result of divorce and remarriage may impact perceived family obligations and close personal relationships. It is important for family life educators to identify these important sources of resilience and support them in their efforts to improve the well-being of aging persons. It is expected that older persons who maintain close relationships with family members, especially adult children and stepchildren, will utilize fewer social services and incur fewer related health costs.

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# Communications marketing tactics among agritourism operators

#### Issue

The recent rise in popularity of agritourism operations across the nation has spread to the state of Arkansas, and

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small agritourism enterprises such as pumpkin patches, pickyour-own orchards, and on-farm farmers' markets, are gaining visibility across the state. Some experts view adding an agritourism enterprise as a sensible method of making a family farm more economically diverse and sustainable. With this rise in popularity of agritourism businesses, it follows that increasing numbers of farmers across the state are seeking to learn more about starting and managing an agritourism enterprise. The logical place for them to go for information is the University of Arkansas Division of Agriculture. In particular, researchers have learned about several aspects of agritourism that these business owners want to learn about. Among the most important is how to market and promote their businesses more effectively through advertising and media relations. Therefore, in preparation to meet this demand for educational materials, UA researchers have surveyed agritourism business operators in Arkansas to determine the educational needs that they, themselves, believe are most pressing.

#### Action

A team of researchers in the University of Arkansas Division of Agriculture surveyed more than 300 known agritourism business owners in Arkansas, as identified by educational program coordinators at the Winthrop Rockefeller Institute. This survey identified the most important topics, practices, and skills that agritourism business owners want more education about. Result indicated that agritourism business owners desire more education about how to conduct media relations, how to facilitate word-of-mouth marketing, and how to incorporate on-site marketing tools into their businesses.

#### Impact

The results of this study are providing guidance to several organizations, including the Winthrop Rockefeller Institute, the University of Arkansas Division of Agriculture, and the Arkansas Agritourism Initiative in developing educational materials and programming for the agritourism industry in Arkansas. Ultimately, these well-guided educational efforts are leading to better-educated agritourism business owners and, therefore, to more profitable family farms across the state.

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University of Arkansas Division of Agriculture, Extension Public Issues Education Center

# Institute establishes partnerships in food processing industry

#### Issue

The food processing industry continues to be the number

one manufacturing sector employer in Arkansas. However, an increased emphasis is needed on research and technology transfer to solve problems and expand opportunities for further processing of agricultural commodities in Arkansas and the region. Adding value by further processing increases the economic benefits of agricultural production. Creative organizational approaches are needed to increase involvement of the food processing industry in land-grant university research, Extension and education.

#### Action

The University of Arkansas Division of Agriculture in 1995 established the Institute of Food Science and Engineering (IFSE) to assist food processors in framing issues, focusing efforts and solving problems. The Institute promotes and supports research to assist industry in solving its research problems, both fundamental and applied. The goal is to create partnerships among private companies or industry groups and university scientists and Extension specialists from a variety of disciplines and departments, transcending traditional institutional boundaries that can be barriers to cooperation. The Institute's multidisciplinary research expertise offers an integrated approach to developing and disseminating scientific information associated with production, value-added processing, safety, nutritional value, packaging, storage and distribution of food products.

The Center for Food Processing and Engineering's primary objective is to facilitate research leading to value-added products and improving the efficiency and effectiveness of the processing of agricultural products. Its strategy of forming research partnerships with food companies has insured that IFSE-affiliated scientists are addressing research problems of vital importance to industry and meeting its needs. Activities of the Center for Food Safety seek to maintain or improve the safety of foods through production, harvest, processing, distribution and storage. A new emphasis is creatively applying fundamental-based science to resolving food safety issues. Based upon rapid methods of pathogen detection and typing, potentially dangerous food contaminants can be quickly identified, food authorities and suppliers notified, and items removed from distribution channels, thus reducing public exposure. More natural and less-known host defenses and host preventive strategies are also being investigated. The Center for Human Nutrition and Functional Foods seeks to enhance the availability of important phytochemicals in foods, promote their inclusion into popular menu choices, and be an important, catalyzing resource for the effective advocacy of healthy, nutrition-rich dietary choices, with particular emphasis on targeting the population groups in Arkansas and the region at greatest risk for nutrition-related health problems.

#### Impact

The Institute of Food Science and Engineering has sponsored 120 specific research projects, in addition to general research in eleven major research program areas, in the past fourteen years, partnering with 166 companies from 34 states and eight foreign countries.

Arkansas is the leading rice-producing state. Thirty-six major rice processing companies, accounting for the vast

majority of rice processed in the United States, have financially supported the Rice Processing Program sponsored by the Institute. Rice processors have never before participated in a joint research program "for the good of the industry" on this scale. The Program encompasses five main areas of research emphasis: drying, storage, milling, quality assessment, and the cereal chemistry of rice and rice products. Rice processors are gaining new understanding of factors that affect yield and quality of processed rice products. This information is impacting operations ranging from harvesting and storage of head rice to milling operations and storage of processed products. The economic benefit of this research is tremendous. As an example, a single project promises an improvement in head rice yield that could increase industry returns by seven million dollars annually.

Other major program areas are processing of vegetables and fruits, wine and other grape products, pickled vegetables, sensory and consumer science, food microbiology, functional foods, human nutrition, thermal processing of value-added poultry and meat products, carbohydrate chemistry, and lipids and oils. Completed sponsored projects in the area of vegetable processing provide industry with millions of dollars of increased returns annually. The patented vineyard mechanization systems have been commercialized, having demonstrated labor cost reductions while maintaining or improving yield and fruit quality. The ability to manage yield through "balanced cropping" may prove even more valuable. As the systems become more widely adopted, tens of millions of dollars will be saved annually. The thrust to provide small farmers and entrepreneurs with information about the production, development of affordable further processing techniques, analysis of accessible marketing channels, etc. of value-added specialty products is being expanded. Publications include over 360 refereed articles and eighteen other publications.

UA resources developed or enhanced through Institute programs include a unique professionally-trained descriptive sensory panel for analysis of diverse food products, and thermal processing capabilities and a product development kitchen for product development and improvement. Food quality and safety activities have included joint efforts to assure that imported products meet U. S. standards for quality and safety.

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#### Funding

USDA Special Grants; Multiple Industry Grants; University of Arkansas Division of Agriculture

# Economic impacts of the agriculture sector on the Arkansas economy

#### Issue

Agriculture has been a primary stimulus of economic growth in Arkansas since statehood. While agriculture contributes to the economy through direct agricultural production and value-added processing, it also plays an important role through its interactions with other sectors. The use of nonagricultural goods and services as inputs into the agriculture sector promotes diversified growth in the economy, thereby allowing agriculture to remain a vital part of the state economy.

#### Action

The total economic impact (direct, indirect and induced effects) of agriculture (production and processing for crop and animal agriculture and forestry) on value-added, employment and wage income was estimated for the latest year data are available for extensive analysis, 2007. Agriculture is responsible for the creation of 68,617 jobs, or 17.0% the state's jobs, \$9.2B or 15.4% of the state labor income and \$15.2B or approximately 16.3% of the state's value added. While agriculture generates value added, employment and wages in all of the study sectors, roughly 48% of agriculture's contribution occurs in industries outside of agriculture such as Wholesale and Retail Trade, Trans-portation, and Government/Non-NAICS. Individually, the crop, animal agriculture and forestry sectors provide the catalyst for the direct creation of \$2.8B, \$2.2B and \$2.8B, respectively, in value added and 59,314 crop sector jobs, 57,610 animal agriculture sector jobs and 33,259 forest sector jobs.

#### Impact

The total impact of agriculture on the Arkansas economy has remained relatively constant in the past several years despite depressed agricultural commodity prices and market imbalances in supply and demand. Arkansas remains more dependent upon agriculture for its GSP than do its neighbors in the Southeast. The vital importance of agriculture to Arkansas' economy, particularly rural areas of the state with limited alternatives for economic activity and growth is highlighted by the significant economic activity generated in associated industrial and human service sectors as a result of the indirect and induced impacts of agriculture. Research results of this project are highlighted to assist governmental and business personnel and policymakers in deciding upon and pursuing appropriate and positive courses of action that directly and indirectly affect the agricultural and rural communities of Arkansas.

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University of Arkansas Division of Agriculture

# Agritourism development in Arkansas: economics and associated constraints

#### Issue

All across the United States, small and medium scale farms are dwindling in numbers and their incomes are stagnating. To revitalize rural agrarian economies, agritourism activities are being used as a catalyst to generate supplemental income and trigger economic growth. While there have been studies that have estimated the economic impacts of agritourism in several states, no study has focused on the state of Arkansas.

#### Action

In order to learn about Arkansas agritourism businesses as well as what information would be most useful to them, the University of Arkansas Survey Research Center (SRC) was commissioned to survey owners and/or operators of agritourism businesses in Arkansas.

A list of 318 previously identified agritourism operators compiled by Arkansas Agritourism Initiative partners was used as the basis for this survey. This list represents the most comprehensive database of agritourism enterprises in Arkansas. Eight records were removed from the list because no telephone number could be found. Therefore, a total of 310 telephone numbers were included or this survey. From the list of 310 Arkansas agritourism enterprises, the SRC was successfully able to interview 108 owner/operators in February and March of 2009. Of these, 102 own and/or operate agritourism businesses and 6 own and/or operate businesses that serve agritourism businesses.

#### Impact

The study contributes increasing information to stakeholders regarding potential impacts from agritourism ventures. The agritourism industry in Arkansas is still in its infancy. Based on this study, agritourism currently contributes approximately \$7.9 million directly to Arkansas agriculture and about \$12 million to the state's economy. Agritourism accounts for 105 agricultural jobs in the state and a total of 155 jobs in all sectors of the economy. While agritourism represents a tiny portion of the total agricultural economy, many small and medium-sized farms have found agritourism to be beneficial in augmenting household income by generating an additional source of income (study found agritourism revenue was roughly \$43,650 per year, but no data were collected on agritourism expenditures). Given the fact that the state has 49,346 farms, agritourism is a relatively underutilized agricultural diversification strategy that offers potential for the farming community to tap into their available resources and start new enterprises.

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University of Arkansas Division of Agriculture, Arkansas Cooperative Extension Service, Public Policy Center

# Wholesale nursery is an alternative enterprise for row-crop producers

#### Issue

Producers of traditional row crops (e.g. rice, cotton, soybeans) in the Delta region of Arkansas are looking for agricultural alternatives to stabilize and potentially increase farm revenues. Ornamental horticulture is one of the fastest growing segments of agriculture in the United States. Nursery production in Arkansas, ranked at 32nd in the United States, is considered the sector with greatest growth potential. Access to major transportation lanes, reasonably priced agricultural land, labor, water, and other resources makes Arkansas a prime state for large-scale nursery production. According to a Cooperative Extension Service (CES) survey in 2003, 45% of woody plant material in Arkansas is imported from other states. Arkansas nursery products could also be exported to many states. A majority of county agents are not technically trained in horticulture, and need assistance in handling horticulture issues. Existing ornamental horticulture businesses require training and exposure in new plants and production methods to stay competitive. Tremendous opportunities exist for new ornamental horticulture business in Arkansas but these businesses require training and technical assistance.

#### Action

Cooperative Extension Service programs are designed to focus efforts on enhancing current ornamental horticulture businesses and to start new businesses. CES programs are focusing their efforts in 4 primary areas:

- Extension programs provide technical training and support for new and existing ornamental horticulture businesses and county extension agents.
- Printed and internet based fact sheets and a quarterly newsletter are distributed to existing ornamental horticulture businesses.
- Web-based materials are being designed to support quick access to timely and intensive graphics based information.
- A statewide plant evaluation program initiated in 1999 is designed to evaluate and help market 'new' plant material for the Arkansas market.

#### Impact

Cooperative efforts by a team of faculty and staff have helped the third largest rice producer in the Delta region transition from rice to wholesale nursery production. The farm, located in Harrisburg, has planted a total of 120 acres of ornamental trees since the spring of 2002 with an estimated wholesale value of \$2.5 million. This same team of university experts is also helping a former row-crop farmer in White County transition to ornamental shade tree production. In 2005, field nurseries started production in Clay and Jackson Counties and container nurseries started production in Washington and Independence Counties. An additional nursery started container production in Washington County in 2006.

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Arkansas Green Industry Association; Arkansas Farm Bureau; Arkansas State Plant Board; University of Arkansas Division of Agriculture

# Networking strategies to promote and improve the farmers market experience in Arkansas

#### Issue

The interest among Arkansas consumers for local farm fresh produce has increased, attracting new growers to direct marketing. New markets have developed across the state while established markets are expanding. Within the increasing expectations and needs of consumers and the development of local farmers markets, the market managers and vendors are facing new challenges. A new development in local farmers markets is an influx of immigrants has changed the demographics on both sides of the market table, sometimes dramatically, bringing both opportunities and challenges. Market managers, established vendors, and new market members, all have education needs in order for producers to successfully produce marketable crops, for the new markets to survive and established markets to grow, and for market managers to successfully manage their markets.

#### Action

A year-long project was initiated in 2009 with two objectives. First, to develop, coordinate and host a statewide training conference for market managers and vendors with the goal of improving Arkansas farmers markets. Second was to conduct market surveys and evaluations in selected markets in two geographic regions of the state with the goal of identifying significant successes and opportunities for market development.

In February 2009, a state-wide Farmers Market conference was hosted in Fayetteville bringing together more than 140 market managers and vendors for training.

During the summer of 2009, project staff visited 12 farmers markets in Northwest and Central Arkansas to evaluate markets. Results of the survey were compiled and presented at a day-long workshop for the market managers of the surveyed markets in the autumn of 2009.

#### Impact

This project contacted more than 140 farmers market managers and vendors, and other local commercial interests in local foods. The project will strengthen farmers markets and provide opportunities for both producers and consumers. This project directly impacted more than 140 farmers market managers and vendors, and other local commercial interests in local foods and enhances their performance effectiveness through education and collaborative interaction.

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USDA AMS Farmers' Market Promotion Program; University of Arkansas Division of Agriculture

# Family relationships impact quality of care for older adults

#### Issue

Changes in the economic climate combined with the lengthening of the life span can increase older adults' dependency on multiple generations of family members for support in their later years. For example, it is increasingly common for a 70 year old woman to be providing personal care for a 90 year old parent while also needing support from her own children for more instrumental care like home repair or transportation. The care provided by family members for frail older persons, especially in rural areas, reduces the financial and social costs to government support services and communities. Simultaneously, it assures that older adults receive the care that they need as their health fails.

#### Action

Research has consistently found that caregiving support is more likely to be given and received when emotional bonds are positive between the giver and the receiver. Because the majority of caregivers are women, i.e., daughters or daughtersin-law, it is essential to understand the often troublesome relationship between daughters-in-law and mothers-in-law. It is likely the younger woman will provide care for the older at some point in their relationship. Almost 1000 women responded to a survey instrument circulated via the internet asking about the nature of their relationship with their mother-in-law or their daughter-in-law. They were asked about the positive as well as the negative dynamics of the relationship. The women indicated whether or not they would go to the other for advice or assistance if they needed it. They were also asked how the birth of a child/grandchild changed the nature of that relationship.

The majority of the women reported neutral or negative relationships with their mother- or daughter-in-law. Both mothers-in-law and daughters-in-law were reluctant to ask for advice or assistance from the other. Most indicated three to five other individuals they would turn to for support before asking their in-law to assist them. For both, a spouse was the first person they would ask for assistance if they needed help. After the spouse, daughters-in-law would seek assistance from a mother, sibling(s) and other family members or friend(s) before turning to their mother-in-law. For mothers-in-law, if a spouse was not available, they would turn to a daughter or other close family member before going to their daughter-inlaw for assistance. The majority of the women reported that the quality of the relationship changed substantially when

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a child was born. Surprisingly, about half of them reported that the relationship improved, the other half indicate that it deteriorated. Two consistent factors were found to improve the relationship. One was the element of time in the relationship. This finding suggests that maintaining long-term, positive relationships between mothers-in-law and daughters-in-law is the best way to assure the availability of caregiving support for mothers-in-law in later life. The second factor that facilitates positive relationships was clear communication. Although length of time in the relationship cannot be adapted, training in communication skills and conflict management can provide a more positive environment in which the mother-in-law daughter-in-law relationship can grow.

#### Impact

As state and community budgets continue to suffer losses, strengthening and maintaining positive family relationships between women within the family network will provide the support base for frail older family members in need of assistance. Training family life educators and community workers in good communication skills and conflict management techniques so that they can share those skills with others will do much to assure the safety and care of older adults with physical and emotional limitations.

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University of Arkansas Division of Agriculture, AES research support

# Adapting the customer satisfaction index to the lodging industry: Foreign customers' evaluations

#### Issue

As a standard form of measuring customer satisfaction, the Customer Satisfaction Index (CSI) has been utilized in many countries. By using the Korean Customer Satisfaction Index (KCSI) methodology, this study attempted to investigate foreign customers' evaluations of luxury hotels in Seoul, South Korea. In doing so, some efforts were made to overcome the methodological problems associated with the KCSI for the lodging industry. This type of research provides insufficient actionable information for marketing managers due to the complexity of employed statistical techniques such as confirmatory factor analysis and structural equation modeling. In this article, a way of measuring customer satisfaction is demonstrated that retains the much-desired simplicity. The objective is to offer hotel managers and related business operators a diagnostic, easily implementable method of measuring customer satisfaction. In doing so, the customer satisfaction index (CSI) approach is adopted and adjusted.

#### Action

Data for this study were collected through a mall intercept survey using a self-administered questionnaire. Precisely 783 responses, comprised solely of foreign guests who had stayed at a luxury hotel in Seoul, were included in the study. A field study was conducted at the Incheon International Airport and the COEX Mall, a convention and exhibition center in Seoul, South Korea. The majority of the luxury hotels involved in this study were reluctant to authorize customer surveys on their properties. Therefore, the researchers selected the airport and convention center as their survey sites. Following the KCSI methodology, this study calculated the CSI with the perceived value of 40%, overall perceived quality of 40%, and customer loyalty of 20% for luxury hotels in Seoul. Overall, the CSI for the 13 luxury hotels in Seoul was found to be 55.8, which was slightly lower than the domestic customers' evaluations reported by the KMAC.

#### Impact

The hospitality industry has spent tireless years and unlimited resources attempting to find the correct formula to ensure service quality and safeguard customer loyalty. This study has demonstrated one method of measuring customer satisfaction for the lodging industry through the adaptation of the CSI method. The study found the CSI method to be very useful in determining perceived value and overall perceived quality of the luxury hotels surveyed. This study enabled the luxury hotels that were included to construe how their guests ranked them on these two factors in comparison to the competition in the luxury hotel market segment in Seoul, South Korea. Hotel management and personnel can benefit from this study by examining the areas that ranked low on the CSI; these are the areas that focus on poor performance. An additional implication of this study relates to the importance and performance ratings of hotels.

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#### Funding

University of Arkansas Division of Agriculture

# Characteristics of hotel employees that play a role in employee satisfaction and retention

#### Issue

It is critical for hoteliers to understand the factors considered important in measuring employees' overall job satisfaction and their intention to remain at the hotel. Understanding how employees feel about their work environment is only one requirement used in identifying job satisfaction factors. Long-term productive employees lead to an organization's stability, reinforcing the foundation of the stabilization theory by stating: employees who are satisfied with their jobs tend to be more stable within their organizations, thus, contributing to an organization's positive perception within industry. The purpose of this study was to identify whether job satisfaction factors have a relationship with an individual's overall job satisfaction and their level of intention to remain at their current workplace according to employment characteristics.

#### Action

One thousand, four hundred and eighty nine questionnaires were distributed for this study. The population consisted of employees of a particular lodging property management company that operated twenty-four properties in Arkansas, the District of Columbia, Florida, Georgia, Louisiana, Mississippi, North Carolina, Tennessee, and Texas. Participants whose native language was Spanish received a questionnaire in Spanish, eliminating the possibility of any communication errors. In this study, satisfaction with location of the hotel, English articulation, work accomplishment, department, working condition, working shift, training for daily tasks, career advancement and development, job security, supervisor (personal), supervisor (technical), benefit package, pay, workload, level of opportunity to supervise others, level of different work duty, and my importance in the hotel, were asked.

#### Impact

Since employees are diversified on a multitude of employment characteristics beyond demographics it is crucial that hoteliers are consistently striving to identify what job satisfaction factors are important to maintain employee job satisfaction, and how the level of job satisfaction differ according to individual employment characteristics. Attempts have been made in the hotel industry to provide work environments where employees can achieve a feeling of satisfaction. Such satisfying work environments can be linked to quality service and retaining quality employees, thus reducing turnover rates and training dollars. Researchers and professionals in the hotel industry need to seek effective ways to measure factors that affect employee job satisfaction. Measuring and tracking employee job satisfaction is instrumental to customer satisfaction and is a retention device for most hospitality enterprises.

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# Bikes, Blues, and Bar-B-Que: shopping and tourism patterns

#### Issue

Organizers of the Bikes, Blues, and Bar-B-Que event in Fayetteville, Ark., and researchers have made no attempt to identify the demographic characteristic of the attendees or their shopping beliefs and motivations. Nor has an effort been made to examine the impact that the spending behaviors of the attendees have on local hotels and restaurants.

#### Action

This research utilized a quantitative component. A sixsection attendee questionnaire (developed by the researchers) was administrated during the 2009 Bikes, Blues, and Bar-B-Que event. The first section focused on demographic information allowing the investigators to create a profile of the BBB attendee. The second section included questions related to the attendees beliefs about shopping. Section three of the instrument asked attendees which characteristics were important when shopping for a souvenir. Section four focused on the important characteristics of official BBB merchandise for an attendee. Section five requested the attendees indicate their reasons for shopping at the BBB festival. The final section of the questionnaire asked questions related to the BBB event itself and the attendees' overall satisfaction with the event and the events activities. This section also asked questions related to the attendees spending, shopping, and traveling habits while at the event

#### Impact

This study provided valuable information for the board of directors of BBB, merchants/vendors, the Fayetteville community, and the residents of Northwest Arkansas. The findings provided an updated and rich demographic profile of the BBB attendee and their spending patterns. The information related to characteristics of the attendees shopping preferences and their beliefs on shopping are extremely important to the BBB board and the Fayetteville community. They now have a clearer, more definite profile of the shopping habits of the festival attendees and how to market merchandise to them

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# Society-Ready Graduates

# Improving the lives of young children in Arkansas

#### Issue

How can prospective teachers (University of Arkansas students) of young children in Arkansas receive valuable experiences needed to guide them as professionals? UA students majoring in Child Development, Early Childhood Education, Nursing, Speech Pathology, and Psychology need opportunities to work directly with children in developmentally appropriate early childhood settings. Programs that are accredited by the National Association for the Education of Young Children (NAEYC) and staffed with mentors who have master's degrees are required. Model early childhood programs are necessary as a setting for this valuable training.

#### Action

The programs in both the UA Infant Development Center and UA Nursery School are NAEYC accredited. The master teachers do exemplary jobs of meeting the needs of the children, parents, and the UA students. This is possible by maintaining high-quality standards and NAEYC accreditation. The teachers model for and mentor the university students as they guide the students in their professional journey.

The teachers and students participate in applied research daily as they constantly monitor the children's progress based on assessment tools and observation and then compare to accepted theoretical perspectives of theorists such as: Freud, Erikson, Dewey, Rogers, Piaget, and Bronfenbrenner. In addition, students taking the course, "Child Development Practicum," conducted a short research project with the children at the Nursery School. Each observation project assigned by the instructor, Mardi Crandall, included a statement of the problem, literature review, methods and results of the observations of children in their everyday play.

#### Impact

UA students reap the benefits of being mentored by master teachers at the UA Infant Development Center and UA Nursery School. This has been my feeling in the past and is still true, influencing the students as they learn developmentally appropriate ways to guide children and plan curriculum makes the greatest impact. The students then go out and mentor other teachers and early childhood professionals and also have a direct impact on the many children who will be in their care.

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#### Funding

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# Beginnings supports child care professionals in Arkansas

#### Issue

The field of child development has become more important as research-based information about teaching methodology has become recognized for its potential to help children succeed. Furthermore, performance benchmarks and quality rating systems for child care services have been adopted in the State of Arkansas. Teachers of young children increasingly seek research-based information to maximize their effect on their students.

#### Action

Beginnings is produced and published four times per year to support early childhood professionals throughout Arkansas. Disseminated through electronic means, the publication is produced by University of Arkansas Child Development faculty and community leaders with expertise in child development. Content addresses classroom environment, child guidance, and teaching methodologies.

#### Impact

Because it is available on the internet, *Beginnings* has the potential to impact the effectiveness of every child care professional in Arkansas and thus, to make a difference in outcomes for children.

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#### Funding

*Beginnings* is published through a collaboration of the Arkansas Division of Child Care and Early Childhood Education, who funds the work, and the School of Human Environmental Sciences at the University of Arkansas; University of Arkansas Division of Agriculture

# Biodiesel education through a mobile demonstration unit in secondary schools

#### Issue

There is a need to identify and develop instructional systems meeting industry needs while providing knowledge about alternative fuel sources. The education of people in all fields of renewable energies is vital to the growth and expansion of renewable energy. Consequently there is much uninformed knowledge held by the general public concerning biodiesel about its manufacturing process, performance characteristics, and emission byproducts.

#### Action

A mobile demonstration unit and instructional materials for educational programs on biodiesel as an alternative fuel were produced and further tailored for specific audiences. The general educational program consists of a one hour technology enhanced PowerPoint<sup>®</sup> presentation outlining basic biodiesel production and engine performance characteristics. A subsequent demonstration follows utilizing a 3-cylinder compression-ignition engine (28 kW @ 3200 rpm), two scale-mounted fuel tanks, fuel tank selector valves, and a computer-controlled water brake dynamometer with a computer output display screen. The engine is operated from either fuel tank (No. 2 diesel or biodiesel) and comparisons of engine performance (power and torque) and fuel efficiency (kg/kWh) are determined. Participants are able to view first hand performance aspects of these two fuel sources and generate personal perceptions made through this educational venue.

#### Impact

This project provides firsthand knowledge related to biodiesel production, use, and performance. Initial demonstrations at secondary locations have impacted more than eight schools with over 250 participants. Analysis of data gathered through this project has seen significant results on knowledge acquisition and perceptions of biofuels.

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Cooperators

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#### Funding

Arkansas Soybean Promotion Board; U.S. Department of Energy; FutureFuel Chemical Co.; Uniersity of Arkansas Division of Agriculture, Arkansas Agricultural Experiment Station

# Using videography and photography to enhance news and feature stories

#### Issue

Agricultural communications continues to change and reinvent itself due to the rapid rate of technological advancement. Therefore, it is important to educate agricultural communications students on accurate journalistic writing and the importance of multimedia to better communicate with diverse audiences. By incorporating photography and videography with solid writing skills, students gain proficiency in communicating advanced agricultural ideas and procedures both in narrative and visual forms. Teaching students to incorporate visual communication media and providing experiences for students to utilize these mediums while maintaining the rigors of reporting, writing, and editing should be a must in agricultural communications courses.

#### Action

Practical experience with journalistic interviewing, news

writing, feature writing, digital photography, and writing for broadcast guided the AGED 3243 (Ag Reporting and Feature Writing) course offered fall 2009. The course highlighted new media and incorporated videography and digital photography. Throughout the course, students had the opportunity to write for specific media including newspapers, magazines, newsletters, radio, and the Internet in an effort to communicate with the agricultural industry and its stakeholders. Beyond the rigors of reporting, writing and editing, the course provided students with an introduction to photography and video, including photo, video and audio manipulation and editing. Students participated in agricultural reporting and individually wrote five news stories and three feature articles for mediums of their choice and in most cases students' submitted articles directly to publication editors. Students learned about proper photography composition and created a photo portfolio that included 26 agricultural related photographs with captions. Students also submitted photos with news and feature stories to visually communicate a story's angle. Students also participated in writing scripts and completed video projects highlighting an agricultural practice, product or service. Videos were posted to YouTube and the AEED web site.

#### Impact

Students usually lack apprehension regarding new communication technologies and often find new and more effective ways to complete tasks associated with electronic media when compared to their instructors. Furthermore, by using photography and videography to assist with communicating agricultural news, students are not only prepared with sound interviewing, reporting, writing, and editing skills they are also prepared to communicate using multiple electronic media formats.

As a direct result of this course, one student won the *Agro-Knowledge* photo contest and his agriculturally related photo will be printed in the 2010 calendar, one student's multi-source feature story was published in the *Vision* online newsletter, six students had stories published in the *Arkansas FFA* Newsletter, two students had stories published in the AEED *Ag Wire* newsletter, and one student had a feature story published in the November 2009 *Ozark Farm and Neighbor*. The following links are to the student group agricultural videos:

- 1) http://www.youtube.com/watch?v=1HckEEojuyE
- 2) http://www.youtube.com/watch?v=gZfn\_Vq2SOo
- 3) http://www.youtube.com/watch?v=meETBQaQnhc

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#### Funding

University of Arkansas Division of Agriculture

# The educational effectiveness of Second Life in teaching graduate-level agricultural crisis communications

Issue

"We live in a society continually affected by natural

disasters, such as hurricanes, tsunamis, and forest fires, and by organizational crises, such as food-borne illnesses, corporate malfeasance, and terrorism . . .. No community and no organization, public or private, is immune from crises" (Ulmer, Sellnow, & Seeger, 2007, p.3). New and experienced communicators need opportunities to prepare for crises, rather than react to them. Traditional classroom-based instruction provides experience through case studies and theory, but it does not provide students with experiential opportunities to develop, implement, and evaluate communication plans to respond to a crisis.

The purpose of this study is to develop a model for using Second Life, an online 3-D virtual world, as an instructional enhancement tool to strengthen quality and effectiveness of student learning and enable faculty to expand competence with innovative technology. Students will engage in problemsolving and decision-making simulations in the context of real agriculture and natural resource crises.

#### Action

Phase one of this three-year research project is underway to identify the value of crisis communication training and current industry needs; assess the current use by students of Second Life in an effort to develop lessons to meet the needs of students; and identify the value of crisis communication training, what types of training are being used, and how often the training is being utilized. Focus groups with students actively involved in Second Life will be used to guide development of lessons to be delivered via Second Life. Centra, an online conferencing system, will be used to evaluate student problem solving in Second Life simulated crisis scenarios.

#### Impact

Outcomes of this study will meet the need of expanding student and continuing education opportunities in agricultural communications and meet the growing need for crisis communicators. There is a small base of agricultural communications programs, four graduate and 27 undergraduate, with a small faculty base to offer quality instruction in the discipline. The development of the simulations and model will enhance the breadth and quality of instruction available to students at all levels.

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#### Funding

USDA (NIFA) – CSREES Higher Education Challenge grant; University of Arkansas Division of Agriculture

# Academic engagement and satisfaction of undergraduate agricultural, food and life sciences students

#### Issue

Student engagement is foundational to academic achievement. It underlies accepted principles of good practice in college teaching and is an important component of a positive campus culture. Therefore, understanding the academic engagement and satisfaction of students in CAFLS may aid faculty and administrators in improving student achievement and retention.

#### Action

Freshmen (n = 205) and seniors (n = 194) in the Bumpers College of Agricultural, Food and Life Sciences (BCAFLS) were compared to each other and to freshmen (n = 1749) and seniors (n = 1341) university-wide on measures of academic engagement and satisfaction. The academic engagement variables were: (i) level of academic challenge, (ii) active and collaborative learning, (iii) student-faculty interaction, (iv) enriching educational experiences, and (v) supportive campus environment. Both freshmen and senior BCAFLS students reported a significantly (P < 0.05) higher level of student-faculty interaction than did freshmen and senior students universitywide. BCAFLS seniors perceived the campus environment to be significantly (P < 0.05) more supportive than did seniors university-wide. BCAFLS seniors rated active and collaborative learning, student-faculty interaction, and enriching educational experiences significantly (P < 0.05) higher than CAFLS freshmen. These findings are important given the empirical evidence linking increased student engagement to increased academic achievement and student retention. BCAFLS administrators and faculty should evaluate the freshmen year experiences of BCAFLS students to determine if changes are needed to enhance student academic engagement. BCAFLS faculty and administrators should highlight these findings when recruiting prospective students, especially those concerned about attending a "large" university.

#### Impact

This research provides comparative data on the academic engagement and satisfaction between CAFLS freshmen and seniors and between freshmen and seniors university-wide. Faculty, staff, and academic administrators can use this data to enhance the academic experiences and persistence of CAFLS students.

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#### Funding

University of Arkansas Division of Agriculture, Arkansas Agricultural Experiment Station

# Youth livestock educational events help enhance national recognition for Arkansas

#### Issue

We need to provide Arkansas youth who have a strong tie to and interest in livestock some educational events that will help prepare students to compete in 4-H and FFA activities on a national basis. Activities that will give students a broad based spectrum of the livestock industry and improve skills that will make them competitive among other states.

#### Action

The Animal Science Department sponsors a Summer Youth Livestock Judging Camp. This summer camp is divided into three days for Sheep, Cattle and Swine and students are given the opportunity to sharpen communication skills through oral reasons. The PLR and Hog Wild Judging contests, Livestock Skills event and Youth Beef quiz bowl are other events that are coordinated through our department that add to the whole educational program for students interested in livestock.

#### Impact

Participants gain an understanding of the livestock industry and why livestock type changes through this program. Students are provided material that will be helpful to them whether they are in a contest or raising and showing livestock at home. Participants also learn, first hand, of the different objectives and management practices of our school farms and how different they can be from other farm objectives within our state or among different states.

During these events, participants gain practical knowledge and experience, and gain confidence in vital areas such as organizational ability, self-discipline, communication, teamwork and decision making. Many students for the first time find what they can accomplish when they work to their potential. Due in part to these events, Arkansas was named National Champions of the FFA Livestock Contest and Reserve Champions at the American Royal 4-H livestock contest.

This year makes the eleventh year the Animal Science Department has sponsored this camp. Many students will return as they work through the different levels of camp and compete in the sponsored contests. These students are introduced to former livestock judging team members, graduate students and animal science professors that help make this camp successful. This program also has a great impact on recruiting students and strengthens the bond to the UA Animal Science Program.

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#### Funding

Private donors; University of Arkansas Division of Agriculture

# Classroom structuring for greater achievement and performance

#### Issue

If you are like most, just entering certain waiting rooms may make you tense. Your reaction to that environment is a learned behavior determined by your previous experiences. For most students with a poor school performance, just walking into a classroom can result in a similar avoidance reaction. A teacher can change that reaction by recognizing that the learning environment can either enhance or detract from the student's ability to achieve.

#### Action

Five basic environmental factors are common to every classroom. The teacher's teaching style, the curriculum, the student's learning style, the classroom management, and the evaluation of students. The teaching style plays a significant part in determining the students' level of motivation. It affects the level of communication between students and teacher. While there are not good or bad styles, some are more effective in motivating students than others.

How the student perceives the activities that make up the curriculum has a lot to do with attitude. Students will respond positively if the teacher explains and makes sure that the curriculum challenges the students. A variety of in-school and out-of-school activities can meet both the educational goals of the class and the student's needs, interests, and expectations.

No two students learn at exactly the same time and in the same way. Learning style is partially based on previous experience and knowledge. To help students learn. Teachers must ascertain how much and what kind of learning has already taken place. Only then is the teacher ready to deliver instruction that matches the students' ability to comprehend it easily and clearly.

Good classroom management motivates by keeping every student involved in activities that are relevant to student needs and tied to clearly stated educational objectives. Once activities are assigned and directions given, the teacher should not interpret a student's task or assign a second activity before the first is completed.

Many students learn early on that tests are something to be tolerated and endured: tests are not perceived as part of the learning process. Many students feel that grades are the only purpose of testing. Unfortunately, teachers usually use grades to rank students, and the higher the rank, the greater the chance for continued success. Every teacher needs to have a comprehensive evaluation and assessment system and use it diligently. Teachers should develop a system that tests each type of student activity and identifies a variety of different test items and techniques that match a range of student abilities.

#### Impact

By creating a non-threatening classroom environment, the teachers may see a higher level of student achievement and performance in the classroom.

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#### Funding

University of Arkansas Division of Agriculture

### 2009 Publications of the Arkansas Agricultural Experiment Station

DISCOVERY: The Student Journal of Dale Bumpers College of Agricultural, Food and Life Sciences, Vol. 10
Marketing Options for Grapes and Grape Products
Early Childhood Public School Teacher Licensure for the Fifty States and Washington, D.C.
Economic Contribution of the Agricultural Sector to the Arkansas Economy in 2007 and Revised Estimates for 2006
Arkansas Turfgrass Report 2009
Arkansas Corn and Grain Sorghum Performance Tests 2008-2009
Arkansas Soybean Performance Tests 2009
Arkansas Cotton Variety Test 2009
Animal Science Department Report 2009
Wayne E. Sabbe Arkansas Soil Fertility Studies 2009
B.R. Wells Rice Research Studies 2008
Summaries of Arkansas Cotton Research 2008

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1 ft = 0.30 meters = 30 cm 1 inch = 2.54 cm = 25.4 mm 1 ounce = 28.3 g 1 lb. = 0.454 kg = 454 g 1 PSI = 6.9 kPa 1 ppm = 1 mg / kg 1 gallon / acre = 9.35 L / ha 1 lb / 1000 ft<sup>2</sup> = 4.9 g / m<sup>2</sup> 1 lb / 1000 ft<sup>2</sup> = 48.8 kg / ha 1 lb / 1000 ft<sup>2</sup> = 43.56 lb. / acre 1 lb / acre = 1.12 kg / ha 1 bushel / 1000 ft<sup>2</sup> = 3.8 m<sup>3</sup> / ha °F = (9/5\*°C) + 32 °C = 5/9 \* (°F-32)

