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Faculty Impact Statements 2010



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UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE

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Faculty Impact Statements 2010

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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 2010 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>

Faculty Impact Statements 2010

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Competitive Agricultural Systems in a Global Economy

Animal Systems

Divergent selection for pale, soft, and exudative-like meat in broilers

Issue

Increased selection for body weight, breast meat yield, and feed conversion ratio in broilers has led to a number of metabolic disorders including the development of pale, soft, exudative (PSE-like) meat. This PSE-like meat is a result of accelerated post-mortem glycolysis that results in paler meat, decreased water holding capacity, increased drip loss, and a decreased ability to form gels. With the increase in the demand for further processed ready-to-eat broiler breast products, this metabolic disorder can have large economic impacts. Although the incidence of PSE-like meat can vary dramatically in broiler flocks, it is estimated that it could cost a single processing plant \$4.4 million per year in lost product. This large economic impact has caused PSE-like meat to become an important issue in commercial broiler selection programs.

Determination of PSE-like poultry meat can be accomplished through several techniques which include but are not limited to muscle color (L-value), post-mortem muscle pH, and drip loss. Muscle pH is an excellent tool in the prediction of PSE-like poultry meat but has limitations associated with cost and assay time. These factors limit its application to commercial broiler selection programs.

Action

Divergent selection for pale, soft, and exudative like (PSE-like) meat in broilers was accomplished through selection for 24 hour L-value in broilers from a population grown to 42 days of age. Selection was based on sire family means for 24 hour L-value in breast meat resulting in the development of two lines selected for either increased 24-hr L-value or decreased 24-hr L-value. Analysis shows that the divergent lines differ in color by an average of 3 L* units after only 3 generations of divergent selection.

Impact

The impact of the data generated from these lines is multifactorial. First, these data will determine if L-value as measured with a colorimeter can be applied as a real time selection tool for the measurement of and ultimately the selection against PSE-like meat in commercial broiler populations. Second, the development of divergent populations allows for the further study of the underlying genetic and environmental factors that lead to PSE-like meat. As previously mentioned, the incidence of PSE-like meat varies in commercial broiler populations. It is also difficult to induce on a repeatable basis thus making it

difficult to study both the environmental and genetic factors leading to this disorder. Therefore, divergent lines that have either an increased or decreased susceptibility to PSE-like meat serve as a more adequate model for the further development of our understanding of both the genetic and environmental causes of this disorder.

Elucidation of the genetic cause for PSE-like meat in commercial broilers would serve as a permanent solution to its incidence. However this change would not occur rapidly as it takes 4 to 5 years for changes on the pedigree level of a commercial selection program to reach the commercial broiler level. But an understanding of environmental factors resulting in PSE-like meat could lead to the savings of tens of millions of dollars through the application of precautionary management techniques prior to slaughter until a permanent genetic solution can be reached.

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University of Arkansas Division of Agriculture

Genomic single nucleotide polymorphism analysis differentiates ascites-susceptible from resistant broilers

Issue

Ascites syndrome in broilers represents the terminal consequence of an initial increase in blood pressure within the pulmonary circulation followed by fluid accumulation in the abdominal cavity. The economic loss due to ascites has been estimated at \$100 million per year in the United States. Indirect economic costs are associated with nutrition and management strategies that successfully reduce the incidence of ascites by reducing metabolic oxygen demand. These strategies prevent broiler producers from fully realizing the profit potential available genetically in modern broilers which, under ideal circumstances, are inherently capable of extremely fast growth coupled with excellent feed efficiency.

Action

Fifteen generations of divergent selection for ascites incidence has been applied to a commercial broiler line at the University of Arkansas. Specific mating combinations between the selected lines were generated and reared as a means to collect phenotypic data and blood/ DNA samples. Tail analysis was applied and those birds known to be extremely resistant

or susceptible to ascites were further analyzed using Single Nucleotide Polymorphism (SNP) analysis. A total of 3,300 SNPs were genotyped. Data analysis resulted in the identification of at least 9 chromosomal regions, each containing four or more consecutive SNPs, which were highly related ($p < 0.001$) to ascites susceptibility. Our goal is to further understand the genetic basis for ascites which will likely aid in candidate gene identification. Once genes are identified, we will determine the degree of relationship with correlated traits of economic importance.

Impact

These data will allow for the development of genetic tests that predict ascites susceptibility and resistance. Identification of such candidate genes could lead to a significant reduction/permanent elimination of ascites in commercial broiler populations. Of course marker assisted selection must proceed with caution. Ascites incidence has accumulated in commercial poultry populations that have been derived from a variety of genetic bases. Therefore, ascites incidence is likely linked with traits of economic importance such as breast yield, feed conversion, rapid growth and body weight at specific ages. Successful application of ascites markers will result in the breaking of linkage groups in critical chromosome regions impacting typical production traits focused on in primary poultry breeding programs and incidence of ascites.

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Economic impact of elimination of ascites-related single nucleotide polymorphism from ascites-susceptible broiler populations

Issue

Divergent selection exclusively for ascites has led to changes in growth related traits. For example, ascites selection has modified late embryonic growth and hatch weight with the ascites-resistant (RES) line being heavier than the ascites-susceptible (SUS) line. By Day 7 post hatch, there is a complete reversal with the SUS line being heavier than the RES line. This difference is maintained through to maturity in unrestricted birds. Ascites selection has resulted in the modification of the pectoralis muscle by increasing the absolute and relative percentages in the SUS line as compared to the nonselected (control) commercial pedigree elite (REL) line. Selection for ascites resistance in the RES line has resulted in a reduction in absolute pectoralis muscle, however relative pectoralis muscle has not been impacted. These data indicate a relationship between breast yield and ascites since breast has been modified in

a population that is selected based solely on ascites mortality. The association between breast yield and ascites may provide insight into why ascites persists in heavily selected broiler populations. These data also suggest that the development of a resistant line could be accomplished without negatively impacting relative pectoralis muscle. We also observed that the SUS line, when reared under normal environmental conditions actually shows improvement in muscle color as compared to the REL line, while not negatively impacting muscle pH, Δ pH, or water-holding capacity (WHC). It is not clear if this relationship will also be a factor when considering the loci on which we have focused. Selection for ascites in the SUS line has resulted in an increase in total heart due to an increase in both right and left ventricle. The increase in right ventricle was expected due to the positive genetic correlation between right ventricle:total ventricle ratio, pulmonary hypertension, and ascites, however, the change in left ventricle was not expected. Overall these modifications in total heart and lung have potentially created a cardio-pulmonary system that is not robust enough to support the rapid growth and muscle deposition and this may be the reason why the SUS line develops ascites so readily when exposed to stressors such as cold or hypobaric stress. It was clear from this work that selection for resistance to ascites without regard to body weight will result in changes to correlated traits consistent with those that would be under selection pressure by commercial geneticists.

Action

A project was initiated to determine which of 26 primary selection traits are most associated with four loci we have identified as major determinants of ascites susceptibility in broilers. Current management practices to reduce ascites entail higher energy costs for heating and ventilation, and feed restriction to slow growth. Based on a whole genome association study and then follow-up genetic analysis in experimental lines produced from a commercial elite line, we identified four major loci for ascites susceptibility. For three of these loci, we have identified probable candidate genes for the ascites phenotype and for two genes identified SNPs in coding sequence. We produced two lines from a commercial elite line through divergent selection for ascites susceptibility, while maintaining the unselected “relaxed” line. The selected lines differ for a number of important production traits even though selection was only based on ascites phenotype. We now propose to produce two successive flocks of 400 birds from the relaxed line. All birds will be genotyped for the four ascites loci, and screened for 26 different production traits. For each of these traits, we will determine the statistical correlation of that trait with genotype for each of the four loci.

Impact

Completion of the proposed research will not only provide the primary breeders a better understanding of the pitfalls of traditional selection methods but also how particular metabolic disorders become entrenched in commercial populations. In addition, the economic cost of marker-assisted selection will be studied for the four ascites-related markers. This will shed light on the feasibility of developing SNP panels for trait selection in commercial broilers.

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Division of Agriculture

The effect of implants and nutrient restriction prior to feeding on carcass composition and quality

Issue

Intramuscular fat or marbling is related to flavor, tenderness, and juiciness of beef, making it crucial to beef eating quality and consumer satisfaction. Beef from high Choice carcasses has a 10% chance of producing a poor dining experience, while beef from a USDA Select carcass has a 25% chance of a poor dining experience. During the 20 year period from 1986 through 2005, the percentage of cattle grading USDA Choice has declined from 93.6% to 57.2%. According to the National Beef Quality Audit (NBQA), exporters of beef have cited carcass quality as the second most limiting factor in their ability to export U.S. beef. In the NBQA, cattle producers ranked “insufficient marbling and low quality grades” as the leading beef quality challenge facing the industry. Along with the reduction in carcass quality, the number of cattle scoring yield grades 4 and 5 has more than quadrupled since 1997, which is the fourth ranked challenge facing the beef industry. Increased costs of feeder cattle, longer feeding periods, and narrowing of choice-select price differential have spurred feedlots to increase implant frequency and potency. Previous research indicates that aggressive implant regimens of calves entering the feedlot has no impact on carcass quality, but hormonal implants of cattle facing nutrient restriction prior to feeding can reduce the percentage of cattle grading choice by 50%. The primary purpose of this study was to focus on implant status and nutritional energy balance and their effects on carcass quality characteristics, tenderness, and eating quality.

Action

Cattle from the Southwest Research and Extension Center (SWREC) spring calving cowherd, primarily of Angus ancestry (75% to 87% Angus), were weaned at 7 months of age and backgrounded for 63 days at the SWREC feedlot facility. At the end of backgrounding, one third of the calves were sent directly to a commercial feedlot for finishing, the remaining calves stayed at the SWREC for either a restricted (1.0 lb/d) growth or unrestricted (2.0 lb/d) growing program prior to finishing as yearlings. Additionally, one half of each group (calf-fed, restricted growth, or unrestricted growth) received hormonal growth implants at the beginning of backgrounding and during the growing period. At the feedyard, all cattle were implanted and fed steam-flaked corn based finishing diets until the average backfat thickness for each group reached 0.5 inches.

Impact

Before entering the finishing phase, calves and yearlings implanted prior to finishing gained bodyweight 8% (calf-fed), 40% (restricted growth), or 17% (unrestricted growth) faster than cattle not implanted prior to finishing. During finishing, yearlings gained 16% more per day than calves. Finishing as calves resulted in lighter carcasses with smaller ribeye area, and fatter carcasses compared to finishing as yearlings; but cattle finished as calves were higher in marbling and had greater quality grade (97% USDA Choice quality grade) than yearlings (85% Choice). Implanted cattle in a restricted growth program had less marbling and lower quality carcasses (74% Choice) than restricted growth yearlings not implanted or unrestricted growth yearlings (91% Choice). This research indicates that implantation should be delayed if cattle are placed on a grazing program when a nutrient restriction is expected and cattle are to be marketed on a grid that places economic emphasis on carcass quality.

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In ovo injection of dextrin-iodinated casein solution in turkey embryos

Issue

In commercial turkey production, poults have a relatively wide range with regard to timing of hatch. Poults that hatch early in this 48 hour window can become dehydrated while they remain in the warm hatcher environment and will consume nutrients (fats primarily) in their yolk sac. The yolk sac ‘feeding’ can support the animal’s needs for about 48 hours. After 48 hours, the poult will begin to break down proteins for energy including maternal immunoglobulins that are crucial for meeting disease challenges. Another common practice in turkey production is that poults may be transported for great distances before they reach a farm and have access to feed and water. During this time, the poults, especially ones that hatch early, will continue to break down proteins for energy. This can result in a highly compromised immune system, keto acidosis, and extremely poor poult quality such that these severely metabolically challenged poults exhibit a generalized failure to grow and thrive, or die.

Action

Experiments were conducted with a local commercial turkey integrator. Turkey eggs were injected after 25 d of incubation with isotonic solutions comprised of dextrin (18% maltodextrin and 10% potato starch dextrin) in com-

bination with 15, 75, or 375 micrograms of iodinated casein. Iodinated casein represents a method of accomplishing thyroid hormone-like activity with natural ingredients. Hatch weights and hatchability were determined on a total of 3900 and 5200 turkey eggs in Experiment 1 and 2, respectively. A portion of the turkeys were tagged for identification and raised in commercial turkey houses and body weights obtained between 6 and 7 days for each treatment. In the 2 studies, turkey embryos treated with dextrin and 75 micrograms of iodinated casein exhibited significantly higher hatch weight (1.8% to 4.3%), hatchability (2.4%) and 6 day poult weights (1.8%) compared to control injected turkeys.

Impact

The commercial turkey company we worked with places roughly 40,000,000 poults per year. Since each hatched poult is worth approximately \$1 each, a 1% improvement in hatchability alone would be worth approximately \$400,000 per year for that integrator. If a 2.4% improvement in hatchability was consistently obtained by the company, this would equate to \$960,000 for the company. Because higher hatch weights generally are associated with increased growth, feed conversion, and livability, there is great potential for increasing profits for turkey companies and growers by treating turkey embryos with the dextrin-iodinated casein solution.

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Funding

University of Arkansas Division of Agriculture

Global gene expression associated with high and low broiler feed efficiency phenotypes: 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, feed efficiency remains a very important genetic trait in poultry and livestock. As such, an understanding of the biochemical and physiological mechanisms that control feed intake and energy metabolism is needed to 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 live-

stock. Based on a considerable body of research, investigations of global gene expression using some of the latest microarray, bioinformatics, and analytic software have been carried out and at least two publications are pending. We feel that these publications could help in understanding the fundamental basis for feed efficiency and hopefully point the way toward potential biomarkers and metabolic pathways that are responsible for producing superior or desirable feed efficiency phenotypes.

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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Assessment of broiler breeder lines

Issue

Primary breeders continue to improve the genetic potential of broilers and their subsequent carcass yields. However, as the genetics for growth continue to improve in broilers, the breeder performance becomes more challenging to manage. Therefore, broiler breeder research in our laboratory is designed to continue learning more about these new genetic lines and how they can be managed by integrators and producers.

Action

Various management trials evaluating the reproductive performance of broiler breeder males and females have been conducted.

Impact

Information generated in our laboratory has been utilized by primary breeder companies to construct breeder management guidelines, which encompass management procedures for 80% of the world's parent stock broiler breeders.

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Direct selection of cattle for resistance to fescue toxicosis

Issue

Problems with beef cattle grazing endophyte-infected tall fescue in the mid southern United States have been extensively documented. Losses in milk production, calf growth, and reproduction have been reported. These losses annually are conservatively estimated at \$354 million in reduced calf numbers and \$225 million in reduced weaning weights. Be-

cause endophyte-infected tall fescue is the primary cool season forage for cow-calf production in Arkansas, additional research is needed to determine ways to manage cattle on this forage. One important aspect of cattle management is selection of future parents. This work involved a study of the influence of Heat Shock Protein-70 (HSP-70) haplotype (gene) and forage systems on milk yield and milk composition of beef cows.

Action

Genomic DNA from 117 Angus, Brahman and reciprocal-cross cows was used to determine the influence of HSP-70 haplotype and forage type (endophyte-infected tall fescue or common Bermuda grass) on milk yield and composition (protein, fat, somatic cell count).

Impact

The effects on milk yield estimates for possible single nucleotide polymorphism in the HSP-70 gene and forage type were sufficiently large for application by Arkansas cow-calf producers in adapting genotype to the forage environment. Molecular diagnosis currently available to distinguish between those causal variants will allow genotypic information to be used by Arkansas producers for direct selection of parents more tolerant of the effects of endophyte-infected tall fescue at the herd level. Increased reproductive rates and weaning weights could be worth millions to Arkansas cow-calf producers.

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Funding

University of Arkansas Division of Agriculture

Importance of Brahman breeding to southern cow-calf production

Issue

Results indicate that in the hot, humid Southeast and Gulf Coast regions and even in more temperate areas of the United States, the weaning productivity of Brahman \times *Bos taurus* cows is virtually unequaled; however, problems have been identified with Brahman breeding. Specifically 1) subpar reproductive performance of Brahman bulls; 2) increased dystocia or reduced survival of Brahman-sired calves; 3) price discounts of Brahman-sired steers and surplus heifers; 4) unfavorable carcass attributes such as tenderness; and 5) nondocile temperament. These factors have provided an impetus to evaluate alternative sources of subtropical adapted beef cattle germplasm in the Southeast and Gulf coast regions. Because of the widescale use of the Brahman breed in the Southeast and Gulf coast regions, Brahman was the sire breed to which other sire breeds were compared.

Action

The sire breeds compared were: (1) Brahman versus traditional *Bos taurus* sire breeds; (2) Brahman versus other *Bos*

indicus sire breeds; (3) Brahman versus *Bos indicus*-derivative sire breeds; (4) Brahman versus *non-Bos indicus* subtropically-adapted sire breeds; (5) *Bos indicus*-derivative versus traditional *Bos Taurus* sire breeds; (6) *Bos indicus*-derivative versus *non-Bos indicus* subtropically adapted breeds; and (7) *Non-Bos indicus* subtropically-adapted versus traditional *Bos taurus* breeds.

Impact

Evaluation of several *non-Bos indicus* subtropically adapted sire breeds suggests that some sire breeds may serve as alternatives to some *Bos indicus* genetic types because of their ability to tolerate hot, humid conditions in the southeast U.S. and Gulf Coast areas. Specifically, considering Brahman as the standard *Bos indicus* sire breed, results of this review indicate that *non-Bos indicus* subtropically-adapted sire breeds will contribute to less dystocia but are expected to sire progeny that weigh less at weaning, grow at a slower rate post-weaning and have lighter carcasses than Brahman-sired progeny. Further, progeny of *non-Bos indicus* subtropically adapted sire breeds are expected to have slightly improved carcass merit, especially in regard to carcass tenderness, relative to Brahman-sired progeny. In addition it is important to determine if price discounts applied to *Bos indicus*-influenced cattle, will be incurred to progeny of *non-Bos indicus* subtropically adapted sire breeds when marketing occurs through traditional channels.

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Funding

University of Arkansas Division of Agriculture

Broiler strain sensitivity to *Eimeria* species

Issue

Coccidiosis is the most widespread intestinal disease of poultry, the organisms responsible, parasites of the genus *Eimeria*, occurring in all houses where birds are reared in contact with the floor. Annually the disease costs the industry many millions of dollars in lost production and performance. Currently the disease is controlled principally by the incorporation of drugs in the feed and sometimes by vaccination. It has long been known that strains of chicken differ in their susceptibility to the disease. The objective of this study was to quantify such differences by comparing the susceptibility of modern strains of broiler to a mixture of three widespread species of the parasite.

Action

Modern broiler lines were obtained from a local producer of primary breeder stock and their sensitivity to *Eimeria* species determined by infecting them with sufficient parasites to cause weight gain depression and impaired feed conversion without mortality. In a series of five experiments, significant differences between lines were observed. The differences reflected their better resistance against the pathological consequences of infection rather than the ability of the parasites to multiply in the intestine of the birds. The immunological basis of these observations is currently under investigation.

Impact

Genetic selection of broiler lines better able to resist *Eimeria* infections in poultry could be an alternative to expensive current methods of control. This could result in considerable cost savings as well as limit the use of drugs in poultry production.

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Management factors to alleviate 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 that partial use of 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

In a completed 3-year study, 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+ exerts the greatest negative impact on cattle. This equated to each group being moved to NE+ for 1 month prior to breeding and weaning.

Impact

Cow-calf producers that graze predominantly toxic tall fescue pastures would benefit greatly from a fall-calving season or by converting a portion of their E+ acres to NE+. Fall-calving cows appeared to tolerate E+ to a greater extent than spring-calving cows resulting in 48% greater calving rates, and 47 lb greater actual weaning weight compared with spring-calving cows. The combination of additional weight and seasonal price fluctuations resulted in \$85 greater value per calf sold and

\$226 per cow exposed from fall-born compared with spring-born calves. Replacing 25% of the E+ pasture area with NE+ resulted in 82% greater calving rates by spring-calving cows, 7% greater calving rates by fall-calving cows, and 19 lb heavier calves that were worth \$6 more at weaning than cows that only had access to E+ throughout the year. When adjusted for calving rates, cows given partial access to NE+ produced 112 lb more calf weaning weight worth \$111 more than cows with access to only E+. Replacing all of the E+ pasture with NE+ for spring-calving cows did not increase calving rates compared with those with 75% E+ and 25% NE+ pasture, but increased weaning weight and calf sale value by 82 lb and \$56, respectively. However, conversion of all E+ acres to NE+ is not feasible in most situations because of expense and topography. Based on this information along with previous research at the same location, profitability and sustainability of cow-calf producers with predominately toxic tall fescue pastures could be improved greatly by progressively converting E+ acres to NE+ and by progressively moving the calving season to the fall.

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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 produc-

tion 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

We conducted a feeding study to determine the requirements for broiler breeders for crude protein and amino acids for maintenance and production. Breeders were shown 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. 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 were 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 \$0.25/breeder during the production period. The feed costs per dozen hatching eggs could be lowered by approximately \$0.02/dozen and the number of fertile hatching eggs increased 8% from an average of 145/breeder to 159 hatching eggs. The number of hatched chicks per breeder could increase by 10, increasing revenue by \$3.00 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 world-wide 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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The effect of different 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 skip-a-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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Genetic susceptibility to disease of Smyth line chickens as affected by environment

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 previous efforts by University of Arkansas scientists, the incidence of Smyth line vitiligo has been established to be predictably high and low with and without live herpesvirus of turkey (HVT) administered at hatch (85-95% versus 10%), respectively. Further study of the association of this herpesvirus with vitiligo development in susceptible Smyth line chickens revealed a window in time during which this virus can influence the development of the disease. Incidence of vitiligo dropped from 91% to 35% to 0% when HVT was administered at hatch, at 6 weeks of age, or at 10 weeks of age or older, respectively. Additionally, it was found that Smyth line chickens that have gray-colored shanks compared to the usual yellow-colored shanks do not develop vitiligo. The gray color of the shanks is due to a recessive, sex-linked dermal pigmentation gene. Based on culture studies, the resistance of Smyth line chicks with gray shanks to vitiligo development appears to be due in part to a more robust pigment cell. This was shown in culture where pigment cells from Smyth line chickens with and without gray shanks were exposed to a pigment cell-specific oxidative stress inducer. This treatment resulted in production of oxidative radicals by pigment cell from Smyth line chickens with yellow shanks but not in pigment cells from Smyth line with gray shanks or from other control lines of chicken.

Impact

The above discoveries provide an important new basis for the study of the interplay between genetic susceptibility and environmental triggers. 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, immune-mediated diseases in poultry and humans.

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Weaning management effects on calves persistently infected with bovine viral diarrhea virus

Issue

Bovine respiratory disease is a multifaceted syndrome involving physiological stress, commingling, and several viral and bacterial pathogens. Despite recent advances in biological and pharmaceutical products designed to prevent and control the disease, it remains the leading cause of feedlot morbidity and mortality, resulting in increased antibiotic usage, reduced animal well-being, and decreased growth performance and production efficiency. The treatment costs and production losses associated with bovine respiratory disease are estimated to be at least \$750 million annually.

Several factors contribute to the susceptibility and pathogenesis of bovine respiratory disease, one of the most significant being management and marketing of cattle. Calves born persistently infected (PI) with BVDV are a transmission source of the virus; however, reports on the effects of PI-BVDV exposure on health, production and economic parameters of feeder cattle are limited.

The purpose of this experiment was to observe the health, growth performance, and immune response of calves weaned using different strategies (preconditioned calves vs. calves purchased from auction markets) then subsequently exposed to PI-BVDV.

Action

Five hundred twenty eight cross-bred, male beef calves were used to determine effects of weaning management and PI-BVDV exposure. Two different cattle management sources were utilized for this receiving trial: 1) a low-risk, single-source, preconditioned group of 236 cross-bred steer calves and 2) a high-risk, commingled, auction market group of 292 cross-bred bull and steer calves. Within each source, one half of these calves were penned with and thus exposed to cattle that had been previously identified as PI-BVDV. Body weights, health, and antibody titers were monitored over a 42 day receiving period.

Impact

Preconditioned calves that were vaccinated, castrated, and weaned at their origin ranch had greater gain performance

and reduced morbidity compared to auction market calves with unknown histories. Furthermore, preconditioned cattle had greater antibody titers to BVDV on day 0. Exposure to PI-BVDV reduced gain from days 28 to 42, perhaps due to an additive effect of continuous immune stimulation resulting in nutrients being preferentially utilized for immune pathways rather than tissue deposition. Exposure to a PI calf in auction market calves resulted in the greatest number of chronically ill calves (7.6%), and preconditioned calves had the fewest number of chronics regardless of PI exposure (0.4%).

Our results suggest that costs incurred for labor, shipping, laboratory testing of ear-notch samples, and disposal of animals identified as PI-BVDV may not overcome losses in health or performance of single-source, preconditioned calves during the receiving period at the stocker facility. However, high-risk, commingled, auction market cattle that are naïve and experiencing physiological stress and immunosuppression may warrant testing and removal of PI-BVDV animals.

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Advanced next generation sequencing technology for poultry herpesvirus protection study

Issue

Endemic respiratory viral diseases of poultry, including infectious laryngotracheitis (ILT), continue to collectively cost poultry producers millions of dollars annually. In the case of ILT virus (ILTV) infection, though live attenuated vaccines can protect flocks efficiently, the field outbreaks are mostly related to vaccine, which may cause spreading of vaccine virus from vaccinated to unvaccinated birds, and subsequently the potential reversion of modified-live vaccine viruses to virulent strains. To date, the potential genetic mutations that occurred during attenuation process or during the bird-to-bird transmission were not fully understood.

Action

Research was conducted to identify the unique variations in wild type and vaccine strain of ILTV genomes to obtain complete mutations within the entire genomes compared to a reference ILTV genome sequence. Genomes of one wild type and two vaccine ILTV strains were sequenced using Illumina Genome Analyzer 2X of 36 cycles of single-end read. Analysis of the ILTV genome sequences was carried out using a trial version of DNASTar software (including NGen, SeqMan Pro, Gen Vision), Blastx and Microsoft Excel. Results showed many amino acid differences distributed across the viral protein coding

regions of the three ILTV genomes compared to the reference genome sequence. The sequence differences demonstrated the spectrum of variability among the wild type and vaccine strains. Moreover, the results also revealed 52 genes with complete conservation across the 3 strains. These data demonstrated the potential of high-throughput sequencing technology to yield insight into the sequence variation in different ILTV strains. This information can be used to discriminate between wild type and vaccine strains, or among vaccine strains, and further, to identify newly emerging mutant strains. The conserved coding sequences among various ILTV strains can be promising targets to discover a universal, safer vaccine against ILTV.

Impact

The complete pair-comparisons among one wildtype and two vaccine viruses provided insight into the functional gene families that can influence ILTV viral life cycle, pathogenesis, attenuation, and virulence. These results will be utilized for the development of more precise diagnostic tools, characterization of viral gene functions, and further, more effective vaccine developments. Ultimately, the knowledge of complete genetic mutations in various viral strains will be utilized to develop a better control strategy for infectious viral disease in the poultry industry.

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Energy supplement can mitigate high blood urea nitrogen

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. Therefore, there is 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 in order 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

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. 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. Therefore, additional supplementation may not be needed under these circumstances.

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Single nucleotide polymorphisms in follicle stimulating hormone region may yield reproductive function markers

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 how genes are turned on and turned off and what regions in the promoter region of genes are important in the control of gene function.

Action

We have successfully identified single nucleotide polymorphisms (SNPs) in the promoter (control) region of the bovine beta follicle stimulating hormone (FSH) gene from bovine genomic DNA. We are using DNA sequence data from these promoter regions to determine if these SNPs may be related to reproductive function (measures of semen quality) in bulls.

Impact

One of the two gonadotropins that are essential for successful reproduction in all animals is FSH. 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 enhance 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. 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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Research points to genetic markers for ascites

Issue

Ascites is a genetically linked condition in broilers that results in pulmonary hypertension and 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 broilers. 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 identify 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. We need to make test matings to determine the value of these single nucleotide polymorphisms (SNPs) as genetic tools for the selection of ascites-resistant broiler lines.

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Genetic markers for bovine respiratory disease resistance

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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Use of polymerase chain reaction to identify cattle parasites

Issue

The correct identification of the genera or species of nematodes 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. 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 larval parasite DNA and the identification of sequences that are unique to specific organisms. Preliminary results are promising but have been subject to errors. We are currently working to develop simple techniques for the isolation of DNA from parasite eggs instead of larvae to eliminate some of the errors we have encountered in working with larval DNA. 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 of 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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Brain structures regulating social behavior in chickens

Issue

Chickens selected as breeding stock are responsible for producing fertilized eggs sent to hatcheries for hatching quality chicks. Continued high levels of fertility in eggs requires a complex sequence of behavior exhibited by males and females. There are two parts of sexual behavior that are exhibited by males, one called appetitive or courtship behavior and the second, consummatory sexual behavior. At this time it is not known what structures in the brain regulate this behavior. Since some flocks of chickens have been reported to have reduced levels of fertile eggs or a more rapid decline in fertility than expected, one possible cause of the decline could be improper mating behavior exhibited by males, particularly with the first phase that involves increasing motivation by both sexes through appropriate appetitive sexual behavior. We therefore designed an experiment to discover one or more brain structures activated in males during this specific phase of sexual behavior.

Action

Five groups of males were used in a study to attempt to reveal the neural structure or structures involved. The first group of males each had access to a hen placed in a floor pen with a rooster. The second group had a female placed in a plexiglass container in the center of the floor pen. Each male could see the hen but could not contact her. Males therefore demonstrated solely courtship behavior. The third group consisted of same sex birds in order to determine brain structures associated with aggressive behavior in males. The last two groups were controls that were not exposed to another bird during the test period. After testing, all males were deeply anesthetized, brains were sectioned and immunostained with an antibody to the protein made by the *c-fos* gene and sections analyzed. The *c-fos* gene is a very useful marker of nerve cells activated during a particular behavior. The one neural structure showing high levels of the Fos protein by males displaying solely courtship behavior was the second medial nucleus of the bed nucleus of the stria terminalis (BSTM2). We knew from previous studies that the major neuropeptide found in many BSTM2 neurons was arginine vasotocin (AVT), a peptide homologous to the mammalian peptide called vasopressin or antidiuretic hormone. Importantly, only males show continuous, strong

production of AVT in the BSTM2 throughout their lives while females stop production of AVT in that nucleus during their development after hatching. We therefore subjected all brain sections to an antibody to AVT to determine which behavioral treatment showed co-localization of Fos protein and AVT. Results showed a much higher number of activated neurons (Fos containing) co-localized with AVT in the male group restricted to courtship behavior. We therefore have evidence that the BSTM2 neurons containing AVT are highly associated with appetitive behavior in chickens.

Impact

These results are exciting in that the same structure in mammals called the BSTM is part of the mammalian limbic system that includes another brain structure, the amygdala, associated with emotional reproductive and agonistic behavior. Determining connections of the BSTM2 with other brain structures using tract tracing techniques will enable us to ascertain a neural pathway regulating appetitive sexual behavior and hopefully a specific marker that poultry geneticists can utilize to predict which roosters will demonstrate the optimum courtship behavior for best egg fertility.

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Division of Agriculture

Robust method for specific amplification of multiple target sequences

Issue

For many applications of genetic analysis, including molecular typing of bacterial strains and single nucleotide polymorphism (SNP) 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 perform an efficient and cost-effective genetic analysis. Multiplex polymerase chain reaction (PCR) involving many pairs of primers has limited utility, because it tends to amplify non-specific sequences as the number of target increases beyond several. 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 current 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 primers 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*. Hairpin primers specific to the desired target regions are designed, flanked by universal primer sequences which help in amplification of enriched target regions. Pyrosequencing using 454 GS Titanium chemistry successfully amplified 20 targets of ~700 bp each in 41 *Salmonella* strains through the use of barcoded universal primers. We also demonstrated utility of this sequencing approach for molecular subtyping of 25 *Salmonella enterica* serovar Heidelberg strains with 17 genes. We termed this strain typing method multilocus sequence typing (MLST)-seq, which is an extension of traditional MLST techniques. The MLST-seq analysis resulted in higher discriminatory power than pulsed field gel electrophoresis (PFGE), providing evidence of the utility of the method to separate genetically distinct isolates.

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 methods include discriminatory capability, reproducibility, and labor and time required for the procedure. Currently, the most advanced typing methods are PFGE and MLST. However, even these methods have their own shortcomings. The superiority of MLST-seq was demonstrated over traditional typing techniques including MLST and PFGE. We have used *Salmonella* as model organism in our study, but this approach is easily applicable for other bacterial pathogens. This amplification method can also find applications in efficient and comprehensive discovery of SNP in chickens and humans associated with important genetic traits when used in conjunction with next-generation sequencing.

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Cooling broiler chickens using controlled surface wetting

Issue

A large amount of water is used by commercial broiler farms to provide summer cooling to flocks of birds, using

either a high-cost, high-efficiency evaporative cool cell system, or a low-cost, low-pressure but low-efficiency fogging system. The current evaporative cooling methods inevitably increase the humidity level inside the chicken houses during the summer. High humidity level is detrimental to heat dissipation by birds, and potentially associated with wet litter conditions.

Action

An alternative method for cooling broiler chickens was evaluated in two tunnel-ventilated commercial broiler houses during the summers of 2009 and 2010 in Northwest Arkansas. Direct surface wetting by sprinkling achieved satisfactory cooling of birds. Bird performance (including feed conversion, livability, and live weights) from sprinkler cooled houses and conventional evaporative cooled houses was not significantly different. Sprinkler cooled houses saved at least 62% of water used by evaporative cooled houses, but consumed an equivalent amount of electricity for fan operations. Litter conditions from the sprinkler cooled houses were equivalent to the evaporative cooled houses.

Impact

Data from these four flocks suggest that surface wetting by sprinkler systems may have a value in poultry production for maintaining bird comfort and productivity while reducing water usage. This information could have a large impact as poultry growers look for economical and effective methods to provide cooling to broiler chickens.

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An examination of dung beetle species present in northeast Arkansas

Issue

Dung beetles are an important ecological component in pastures and can promote efficiency in cattle production. By shredding and fragmenting excrement, dung beetles reduce the smothering-effect and increase the rate of decomposition. Other benefits to cattle producers brought on by dung beetles include reduced populations of pestiferous flies and gastrointestinal nematodes, and improvement of the soils nutrient cycling (which enhances forage growth), aeration, and water holding capacity. A concerted effort to study the dung beetles in Arkansas had been lacking. One species, *Onthophagus taurus* Schreber, was released at a site in Franklin County in 1978, but recapture studies were not reported and its establishment is subsequently unknown. Crowley's Ridge is one of six physiographic regions in Arkansas and the dung beetle fauna appears to be completely unknown. Further, the landscape of Crowley's Ridge and that of the interior highlands of Arkansas is traditionally used for livestock production. Since Crowley's Ridge is disjunct from the interior highlands, and surrounded by delta

which is typically used for crop production, it is a unique area to study dung beetle diversity.

Action

A study was conducted to identify an assemblage of pasture-inhabiting dung beetles, and to examine their seasonal activity. Dung beetles were collected using pit-fall traps at the Arkansas State Farm Complex throughout the summers of 2009 and 2010.

Impact

This study will result in a better understanding of the dung-beetle complex in northeast Arkansas. Understanding what species are present at particular times of the year will provide producers a resource to better optimize these beneficial insects into their pasture ecosystem.

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Consumer acceptance of visual appearance of broiler breast meat with varying degrees of white striping

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. A study was conducted to assess the consumer acceptance of broiler fillets with different degrees of white striping condition.

Action

High resolution digital images of fillets, representative of normal, moderate or severe degrees of white striping, were shown to 75 consumers in a blind study. Over 50% of the consumers indicated that they would probably/definitely not buy fillets with moderate or severe striping. The open ended comments revealed the major reasons for the dislike of the white striped meat were that the fillets looked more fatty or marbled and/or that they thought the meat would be "tough". The results of the study suggest that the white striping does affect the consumer acceptance based on the appearance of the fillets.

Impact

Consumer acceptance in terms of visual appearance is negatively impacted by increasing severity of white striping in the muscle.

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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 2008, 2009, and 2010 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

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 seed-soil 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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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 nitrogen sources to provide their pastures with this plant nutrient. Our research aims at selecting appropriate annual and perennial legume species that could be included in beef production systems.

Action

In autumn of 2007, various legumes species were over-seeded 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 was completed in fall of 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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Cattle performance on mixed warm season grass-legume pastures

Issue

With increasing nitrogen fertilizer costs, beef producers are forced to look for alternative nitrogen sources to provide their pastures with this plant nutrient. Our research aims at finding appropriate annual and perennial legume species that can be part of perennial warm season pastures to support a viable beef production. Ideally, these species would provide enough N to offset costs associated with their planting and would moreover provide sufficient N to the soil mineral pool that is comparable with synthetic N fertilization rates.

Action

In autumns of 2008, 2009, and 2010, crimson clover and white clover were broadcast along with annual ryegrass as winter annual forage into existing bermudagrass pastures located at the University of Arkansas Southeast Research and Extension Center in Monticello. Weaned calves were stocked between January and August in 2009 and 2010 to measure their growth performance in grass/legume pastures compared to control pastures without legumes that received synthetic N fertilizer. This study will continue throughout 2011.

Impact

During the first two years of this study, cattle assigned for the control treatment could be stocked some weeks earlier than

those assigned for the legume treatments. This resulted in an overall weight gain advantage for these animals during spring grazing due to a longer grazing period. However, overall and daily gains during the summer months appeared to be similar among all treatments, suggesting that some atmospherically fixed N by the legumes was carried over from spring. A detailed economic analysis is underway. 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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Effect of GnRH timing following a long-term CIDR-based estrous synchronization protocol on estrous response and conception rates in postpartum beef cows

Issue

Estrous synchronization and artificial insemination allow beef producers to maximize genetic improvement in their operations. However, many beef producers have been reluctant to incorporate this technology. According to data in the National Animal Health Monitoring System Report (2008) only 7.2% of beef cattle operations utilize artificial insemination (AI). This low utilization may be due to the amount of intense management needed for these procedures. Therefore, any improvements to decrease time and labor inputs may increase the use of such technology. Synchronization programs utilizing controlled internal drug release (CIDR) inserts, gonadotropin releasing hormone (GnRH), and prostaglandin F₂-alpha (PGF₂α) have been shown to be successful for estrous synchronization in postpartum suckled beef cows. However, the total time to complete the synchronization program can be as long as 33 days when utilizing a 14 day CIDR insert. Reducing the time between CIDR removal and GnRH dosing from 12 days to 2 days could shorten the program duration by 10 days and potentially make it more attractive for use by producers.

Action

A study was conducted to characterize the response after treatment with a 14-day CIDR insert followed by GnRH dosing either 2 days or 12 days after CIDR removal followed by a PGF₂α injection 1 week after GnRH dosing in postpartum suckled beef cows. All cows utilized for the study were randomly and equally distributed into two treatment groups based on body condition score and days postpartum.

Treatment 1 cows received a controlled internal drug release insert (EAZI-Breed CIDR®) on day 0. On d 14 the CIDR was removed, followed by a 100 µg dose of GnRH (Factrel®) on d 26 and a 25 mg PGF₂α (Lutalyse®) dose on day 33. Treatment 2 cows received a CIDR insert on d 10, with removal of the CIDR on d 24. A GnRH dose was given on d 26, followed by a 25 mg PGF₂α dose on d 33. Cows were equipped with a heat detection patch (Estroject®) at time of PGF₂ dosing. All cows were observed at least twice daily for onset of estrus during the 96 h period following PGF₂α dosing, and cows were artificially inseminated approximately 12 h after the detection of estrus. Seven days following the end of the 96 h estrous detection period, all cows were then exposed to fertile Angus bulls for 56 d. Both treatment groups were evaluated for pregnancy status 21 d after the removal of fertile bulls by transrectal ultrasonography. Fetal size was used to determine which pregnancies resulted from AI versus the clean-up bulls.

Impact

The percentage of cows exhibiting estrus within the 96 h period following the prostaglandin dosing was similar for both treatments with 83.3% and 77.8% for TRT 1 and TRT 2, respectively. The mean interval from PGF₂α dosing until estrus was detected was less ($P < 0.01$) for TRT 2 at 61.8 h compared to 77.9 h for TRT 1. The AI pregnancy rates were statistically similar, but TRT 2 had a numerical advantage at 71.4% compared to TRT 1 at 60%. Overall pregnancy rates were 97.2% and 89% for TRT 1 and TRT 2, respectively. In this study, cows that received GnRH dosing 2 days after the CIDR removal in a 14-d CIDR-Select estrous synchronization protocol had earlier onset of estrus and equivalent estrus detection, AI pregnancy rates and seasonal pregnancy rates compared with cows that received GnRH dosing 10 days after CIDR removal. Reducing the total time of the CIDR-Select program by 10 days increased the convenience and may improve the overall utilization of this protocol allowing Arkansas beef cattle producers to capture improved genetics via artificial insemination.

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Cooperators

Rick Rorie and Toby Lester, Department of Animal Science, University of Arkansas

Funding

Fort Dodge Animal Health, Overland Park, Kan.; University of Arkansas Division of Agriculture

Effects of osteopontin single nucleotide polymorphisms on bull semen quality

Issue

Osteopontin is a fertility-associated protein found in greater concentrations in seminal plasma of bulls that produce higher conception rates. Recent research has shown that polymorphisms found within the osteopontin promoter region on chromosome 6 affects the level of osteopontin produced in milk. Therefore, polymorphisms within the osteopontin gene

might also influence the amount of this protein in seminal plasma. If so, then evaluation of bulls for these polymorphisms might be of value in selecting bulls with higher fertility.

Action

A study was conducted to determine if single nucleotide polymorphisms within the *Bos Taurus* osteopontin gene promoter region were related to sperm quality parameters. Semen was collected weekly from 19 bulls and evaluated for percentage motile, progressive and rapid sperm, using computer-assisted sperm analysis. Each bull was then genotyped for polymorphisms in the promoter region of the osteopontin gene. Eight polymorphisms were identified but none were individually associated with fertility. However, haplotypes based on the individual polymorphisms were found to significantly influence sperm motility parameters. Sperm motility is the most important semen quality parameter influencing bull fertility.

Impact

Comparison of haplotypes, based on polymorphisms within the promoter region of the bovine osteopontin gene, might be useful in selection of bulls with improved semen quality.

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This research was conducted under the objectives of the W-1171 Multi-State Research Project, Germ Cell and Embryo Development and Manipulation for the Improvement of Livestock

Funding

University of Arkansas Division of Agriculture

Genetic markers can help evaluate reproductive efficiency

Issue

Reproductive rates have the greatest 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%. 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 sperm motility when bulls are grazing

toxic tall fescue in summer months. 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

A research model for inducing leg problems in broilers

Issue

Leg problems and lameness increasingly affect fast growing broiler chickens worldwide. Studies investigating practical methods for reducing lameness have been hampered by the sporadic onset and variable incidence of leg problems within experimental flocks. Our objective was to develop a research model for inducing a reliably high incidence of lameness in fast growing broilers, thereby providing a test-bed for evaluating the efficacy of potential preventative strategies and treatment regimens.

Action

We constructed pens with wire flooring to expose broilers to sporadic unstable footing and thereby induce a reasonably high incidence of leg problems and lameness. On Day 1 (day of hatch) chicks were placed at densities of 50 or 100 per pen in Experiments 1 and 2, respectively. Initially the wire frame was placed flat on the floor. Tube feeders were positioned on one side of the pen and the nipple watering system was positioned above the wire frame on the opposite side of the pen. When the chicks reached 2 weeks of age the wire frame was elevated to a 20% slope (Experiment 1) or a 30% slope (Experiment 2), forcing the chicks to walk up and down the sloping wire to drink from the nipples. Cumulative incidences of lameness were compared for 2- to 8-week-old broilers using a z-test, with significance declared at $P \leq 0.05$. The 6.8% incidence of lameness induced in Experiment 1 by the wire floor with a 20% slope did not differ from the 5.8% spontaneous occur-

rence of lameness on litter alone. The 26.7% incidence of lameness induced in Experiment 2 by the wire floor with a 30% slope was significantly higher ($P = 0.01$) than the 10.7% spontaneous occurrence of lameness on litter alone.

Impact

Sloping wire floors can be used to reliably induce reasonably high incidences of lameness, thereby permitting assessments of practical strategies for reducing leg problems during broiler production. This “wire flooring” research model now has been used to validate the use of a probiotic to effectively reduce the incidence of lameness associated with bacterial infections in broiler chickens.

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Funding

Cobb-Vantress, Inc.; Biomin Holding GmbH; 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. Also, with an increase in the numbers of organic and natural production systems, less parasite control is available for more and more animals. Lastly, parasite resistance to chemicals is measurably on the rise in cattle.

Action

Studies were conducted in 2010 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. Our cattle work was performed under INAD status, and results cannot be published until FDA clearance. Suffice it to say that current chemicals are being resisted by parasites, and no new chemicals appear poised for near-future availability.

Impact

It is clear that effective helminth control by chemical intervention is becoming less apparent, and that control measures must be utilized in a more multifaceted approach.

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Funding

University of Arkansas Division of Agriculture; Intervet/Schering; Alpharma/King Pharmaceuticals; Pfizer; Boehringer-Ingelheim

Competitive Agricultural Systems in a Global Economy

Plant Systems

Impact of southwestern corn borer trapping program

Issue

The southwestern corn borer has the potential to cause more economic damage to non-*Bt* corn in Arkansas than any other corn pest. Growers must rely on non-*Bt* hybrids to provide the appropriate refuge for corn expressing *Bt* toxins, but the non-*Bt* hybrids are susceptible to attack by corn borers. Growers often apply a prophylactic insecticide during tassel to protect the plants. This application is often too early and results in waste.

Action

Traps were purchased and disseminated to county agents, consultants, and growers throughout the state to help monitor the presence of the southwestern corn borer moth. Results from trap catches were used to determine whether (and if so, when) an insecticide treatment was needed. An alert was sent out to county agents (who further disseminated the information) to inform growers about the need for and timing of treatments.

Impact

Unneeded insecticide applications were prevented on several fields that contained traps, resulting in \$8-15/acre saved. Over roughly 5,000 acres, this resulted in ~\$40,000-75,000 saved, as well reducing the amount of insecticides used considerably.

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Funding

University of Arkansas Division of Agriculture

Impact of multi-crop insect scouting schools

Issue

While many consultants are well-experienced in cotton scouting, several have been forced to cross-train into scouting other crops (e.g., rice, corn) due to a decline in cotton acreage. With each new season, come new consultants as well.

Several consultants, coupled with their scouts, have attended our bi-annual soybean scout schools as well as our annual cotton scout schools located in northeastern (Jonesboro) and southeastern (Dumas) Arkansas. Although these schools were informative, they were also very specialized in that they have only covered a single crop.

Action

In 2010, cotton and soybean scouting schools were combined into a single, more efficient class, which also included rice and corn.

Impact

Many of the newer consultants that attended, as well as most of the young scouts that were in attendance, reported that they learned much more they had learned in a single-crop scouting school. This was particularly true with those consultants who were still relatively unfamiliar with new crop responsibilities (e.g., corn, rice).

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Funding

University of Arkansas Division of Agriculture; Various agricultural industry companies

Impact of tarnished plant bug sampling/threshold research and education

Issue

The success of the Boll Weevil Eradication Program and introduction of transgenic cottons has led to an increase in importance of the tarnished plant bug (TPB) as pest of cotton in the Mid-South. Compounding the problems with TPB has been the change in the farm landscape where cotton is no longer the dominant crop. Populations of TPB increase in non-cotton crops, where they cause little damage, and then migrate into cotton in large numbers, where they become key pests. Over the past ten years, the number of applications of insecticides to manage TPB has tripled, with the related costs increasing from ~\$7/acre in 1997 to nearly \$26/acre in 2007. The most severe case was seen in the Mississippi Delta in 2007 where an average of 7.5 applications was applied at a cost of \$67.50/acre—compared to the 2007 national average of 0.9

applications/acre at a cost of \$8.81/acre. The TPB has changed from being a sporadic pest of early-season cotton to one that attacks the crop throughout most of the season, but there were few or no changes in its management. Also, there was little consistency or clientele confidence in mid- and late-season treatment thresholds. Recommendations differed among adjacent states, creating confusion among growers and consultants, especially in states with identical growing conditions. In 2005, a coordinated, multi-state effort was begun to alleviate the problems and work toward recommendations that were similar among states.

Action

The collaborative effort produced accurate and efficient sampling methods that were standardized across the Mid-South region, and validated TPB treatment thresholds. The Mid-South entomologists distributed about 1000 black cotton drop cloths to consultants, extension agents and growers. Multiple publications were developed and continue to be distributed to end-user clientele across the Mid-South.

Impact

The unified research effort in conjunction with a consistent educational message increased the adoption of integrated pest management recommendations throughout the region, which underscores the importance of group efforts. Adoption of drop-cloth sampling increased from less than 25% of consultants to more than 75% using this sampling method, which yields more accurate information for making treatment decisions.

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Funding

Cotton Incorporated; University of Arkansas Division of Agriculture

Controlling rice smut diseases through best management practices

Issue

With new rice varieties being made available to farmers each year there is a possibility that plant diseases that were previously not important will become important because these new varieties are more susceptible to otherwise minor diseases. Two such diseases are rice false smut (*Ustilaginoidea virens*) and kernel smut (*Neovossia horrida*). Both diseases have been reported previously, with kernel smut present most years, but not at sufficient levels to cause much concern. With 2009 being one of the wettest and coldest years followed by the warmest and driest year in recorded history, the best and worst of both diseases was present. In 2009, false smut had a major impact on rice production while there was less damage from kernel

smut. The opposite was true for 2010 when false smut all but disappeared and kernel smut incidence increased. The impact of both diseases was accentuated by weather conditions and the susceptibility of newer rice varieties and hybrids. Complicating this was the lack of information on how either of these diseases might be managed without the use of fungicide sprays, and if the application of fungicides would prevent either disease.

Action

Grain samples were collected from a long-term rotation study that contained rotation, tillage, fertility, and variety variables. This study was initiated in 2000 and has been managed in a constant manner for ten years. Grain samples were collected from the combine at harvest. Samples were dried and smut severity evaluated. Sampling was carried out for a four year period (2006-2009). False smut severity was evaluated by counting the number of false smut sori (yellow balls) found in each kilogram of grain. Kernel smut was evaluated by counting the number of symptomatic kernels in each kilogram of grain. Results were analyzed for each year and for all years combined.

Impact

For false smut, tillage and fertility main effects were significant while the interaction of tillage and rotation were significant. For all rotations containing wheat (rice-wheat, rice-wheat-soybean-wheat), there was an increase in false smut in the no-tillage treatment when compared to the conventional-tillage treatment. For those rotations not containing a wheat crop (rice-rice, rice-soybean, rice-corn, rice-soybean-corn, rice-corn-soybean), there was a reduction in false smut in the no-tillage plots when compared to the conventional-tillage plots. These results indicate that no-tillage will reduce false smut in rice when wheat is not included in the rotation. For all rotations and tillage combinations, there was an increase in false smut when nitrogen fertilizer was increased from 100lbs/acre to 150lbs/acre. Over the four year period, the highest incidence of false smut occurred in the rice-soybean, high-fertility, conventionally tilled treatment: the most common used in Arkansas. Kernel smut was a very different disease that was significantly impacted by rotation and fertility. With the exception of the rice-corn-soybean rotation, kernel smut decreased in the no-tillage treatment when compared to the conventional-tillage treatment. Kernel smut was greater at the higher nitrogen level in all rotation and tillage combinations. Varieties varied in their susceptibility to both diseases with the hybrid variety susceptible to false smut but not to kernel smut. There was a range of susceptibilities for both diseases in the varieties tested. From these results, it is clear that proper nitrogen management, reduced tillage, and correct variety/hybrid selection will reduce both false and kernel smut in rice.

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Funding

Arkansas Rice Research and Promotion Board; Arkansas Soybean Promotion Board; Arkansas Corn and Sorghum Promotion Board; University of Arkansas Division of Agriculture

Impact of variable rate seeding on cotton input costs and profitability

Issue

Input costs involved with cotton production continue to increase exponentially from year to year. More specifically, seed costs have increased to record highs. One bag of cotton seed fifteen years ago would cost approximately \$80.00 per bag. With introductions of new technologies and seed treatments a bag of cotton seed in 2010 cost approximately \$550.00 per bag. The result is approximately \$100 to \$120.00 per acre for seed. This ranks planting as the most expensive application during a cotton season. Thus, the objective of this research is to see if the use of precision agriculture technologies, more specifically variable rate planters, will help producers acquire better stands while at the same time reducing input costs for seed.

Action

In 2008-2010 a proposal was submitted and funded by the Cotton Incorporated Grower Support Committee. Research to determine if optimal seeding rates could be identified for individual soil types or points of interest was conducted on three farms in southeast, central and northeast Arkansas. Soil variability was determined and separated by soil type through electrical conductivity measurements. Soil electrical conductivity (SEC) zones were generated using a Veris 3100 mobile electrical conductivity cart. Seeding rates ranging from 25,000 to 68,000 were evaluated spatially for each soil type across the field. Fields were harvest with yield monitors and data were analyzed spatially for each seeding rate.

Impact

Preliminary results of the study indicate that higher seeding rates were required in heavier soil types to acquire an even stand, while sandy soil textures required less seed. Based on these results, five fields consisting of 430 acres were planted with variable rate planters in 2010. Seeding rates in these fields ranged from 27,000 seeds/acre on sandy areas to 50,000 seeds/acre on heavy clay areas of the field. Even stands were achieved on all fields and the average seeding costs were reduced approximately 25% or \$20 per acre. If we consider that there is at least 200,000 acres of fields that contain enough variability for this technology to apply, the savings in seed cost could reach a minimum of \$4 million dollars.

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Funding

University of Arkansas Division of Agriculture; Cotton Incorporated State Producer Board

Impact of foliar fungicides on cotton plant health and lint yield

Issue

Foliar fungicide applications have been promoted by chemical retailers in many crops the last several years claim-

ing increases in cotton yield and fiber quality due to increased plant health characteristics.

Action

In 2008-2010 the Cotton Specialist Working Group initiated a regional project to evaluate multiple fungicides, rates and timings to determine plant health effect claims that lead to increased yield and fiber quality. States included in the regional project were Arkansas, Tennessee, Mississippi, Louisiana, Texas and Georgia.

Impact

Results from the three year, multi-state project indicate that no significant differences in vigor, plant heights, boll number or percent of hard-locked bolls were observed. In regard to claims of increased cotton lint yield and fiber quality, no significant increases in cotton yield or fiber quality were observed in any participating state. An economic analysis was conducted on all of the fungicide treatments and it was determined that the most economical application was not to make an application at all. Value of fungicide applications ranged from \$-35.00 to \$-60.00 per acre. Therefore this data will be instrumental in dispelling myths about potential benefits from blanket foliar fungicide applications and save producers money. Cotton acreage was approximately 505,000 in Arkansas in 2010. If fungicide sprays were prevented on only a quarter of this acreage the result would be a savings of 4.4 million dollars.

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University of Arkansas Division of Agriculture; Cotton Incorporated State Producer Board

Impact of on-farm cotton variety performance program

Issue

Variety selection is the most important and single most expensive decision cotton producers face each year. Introduction of new transgenic technology has led to the rapid turnover of varieties available for producers to plant. Normally three year evaluations are recommended prior to producer adoption of a particular variety. Because of the rapid turnover and continued introduction of new varieties, producers need as much information as possible on the new varieties to make educated selection decisions.

Action

A program to test new cultivars on-farm across multiple environments and growing conditions was developed.

Impact

Results of on-farm replicated variety performance trials provide valuable information to cotton producers on both a local and regional level. The data provided by this program allow producers to place varieties by soil type, growing environment and location. Results of selecting the wrong variety could

lead to crop loss and financial ruin. Yield potential of current available varieties varies greatly which results in \$100-\$200/acre in producer profitability if the correct variety is chosen for each situation.

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University of Arkansas Division of Agriculture; Cotton Incorporated State Producer Board; Bayer, Dow, Monsanto

Arkansas Nematode Diagnostic Laboratory provides assaying service for detection of white tip and pinewood nematodes

Issue

Nematodes continue to be a significant issue in both production and commerce for Arkansas citizens. In addition to continuing difficulties in agronomic and horticultural crops due to direct nematode damage and loss in production due to soilborne nematodes, an increasing concern has been those nematodes that can be of regulatory significance in international trade where Arkansas crops are involved. Two nematode pests that appear to be increasingly important are the rice white tip nematode, *Aphelenchoides besseyi*, and the pinewood nematode, *Bursaphelenchus xylophilus*.

Action

The Arkansas Nematode Diagnostic Laboratory is one of the largest nematology service labs in the southern U.S. We routinely process 1,500-2,000 soil samples for Arkansas growers for nematode identification and quantification. We also assay about 6,000 research samples for Division of Agriculture scientists. A recent addition to our assay capabilities has been establishment of a rice seed assay for detection of the white tip nematode. Our laboratory now provides this service for official samples submitted by the Federal Grain Inspection Service (FGIS) and Animal and Plant Health Inspection Service (APHIS) from shiploads of Arkansas rice seed destined for international ports where phytosanitary certification includes assay for this nematode. Even more recently, considerable interest in exporting pine wood chips from the Arkansas forest industry has focused attention on the pinewood nematode, another nematode pest that is found in Arkansas and is regulated in many foreign markets. We have also established a protocol for assay of this nematode.

Impact

Arkansas rice producers have access to many international markets that would normally be closed because the white tip nematode is endemic in our state. Similarly, wood processors have access to certain international markets because they have access to a pinewood nematode assay service. Our laboratory, in conjunction with regulatory personnel in APHIS have developed assay procedures that are deemed sufficient for detection of these nematodes for regulatory officials who issue the appropriate phytosanitary certification for commerce.

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Funding

University of Arkansas Division of Agriculture; cost-recovery fees

Pest and beneficial status of long-horned grasshoppers revealed through dietary analysis

Issue

Irrigation flooding of rice fields provides a temporary habitat for many insects. Many are aquatic or semi-aquatic species, but others prefer vegetation in or near water. Insects called long-horned grasshoppers are commonly found in vegetation along borders and in rice fields. They are so common that rice growers were curious if the small green long-horned grasshoppers were as voracious and damaging to rice as are pest species of short-horned grasshoppers.

Action

Most methods of assessing the roles of insects in ecosystems have severe limitations. An indirect method is to examine the contents of part of the insect's digestive system, the crop. Food accumulates in the crop before digestion, and fragments often are of a size that allows identification. A total of 1,097 adult and nymph grasshoppers were collected from rice fields during the eleven-week study, the crops were dissected and food identified, to understand the role of the grasshoppers. Results showed that long-horned grasshoppers fed both on arthropod prey as well as on rice leaves, pollen and anthers. Prior to rice panicle emergence, adults fed heavily on arthropods, including rice water weevils and leafhoppers. After rice panicles emerged, adult grasshoppers shifted to feeding on rice anthers and pollen. Late in the season, a few adults were feeding on rice kernels.

Impact

For long-horned grasshoppers, feeding on rice leaves was minimal and not economically damaging. Likewise, feeding on pollen was of little concern because grasshoppers were likely scavenging the anthers and pollen left on the panicles. The few kernels eaten late in the season appeared to be primarily in the soft dough stage. Very few were in the late milk stage of kernel development, and an estimate of yield losses due to feeding on kernels was 0.137 kg per ha (0.12 lb/acre) per day. Thus, losses to long-horned grasshoppers are clearly not economic and do not justify insecticide treatment. The beneficial value of long-horned grasshoppers—from feeding on pest insects—far exceeds the minimal amount of feeding on rice plants.

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Funding

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

New understandings of how mycotoxin-producing fungi “see” corn kernels during infection**Issue**

The contamination of corn with mycotoxins such as aflatoxins, fumonisins, and trichothecenes is a major problem for growers in Arkansas and other U.S. states. Current disease management practices reduce, but do not completely eliminate, the threats that mycotoxins pose to grain quality and food safety. The most promising long-term solution to control mycotoxins in corn is through crop improvement, specifically increased genetic resistance. However, substantial knowledge gaps in the current understanding of mycotoxin biosynthesis are severely hindering efforts to develop resistant hybrids.

Action

A genomics-based approach was undertaken to identify genes in fungal pathogens of corn that are involved in kernel infection and mycotoxin biosynthesis. This effort led to the discovery of a novel fungal gene, named *UBL1*, which is required for both kernel infection and fumonisin biosynthesis in one of the most common mycotoxin-producing pathogens of corn. Further analyses of *UBL1* were conducted to determine exactly how the gene regulates disease development.

Impact

As a central regulator of many genes used by fungi to infect corn and produce mycotoxins, *UBL1* serves a critical role in understanding many fungal corn diseases. Characterization of *UBL1* reemphasized the interconnection between mycotoxin biosynthesis and the amount of starch in the corn kernel, which focuses future disease control efforts on blocking the ability of mycotoxigenic fungi to utilize specific components of corn kernels. Blocking the ability of mycotoxigenic fungi to utilize specific components of corn kernels can be accomplished through both conventional breeding and transgenic approaches. Even a partial reduction in mycotoxin contamination through improved genetic resistance would significantly increase the profitability of corn production.

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Cooperators

USDA regional project NC1183: Mycotoxins: Biosecurity, Food Safety and Biofuels Byproducts.

Funding

Arkansas Center for Plant Powered Production (P3) and the Arkansas Biosciences Institute; University of Arkansas Division of Agriculture

New genome-based weapons to defeat fungal foliar pathogens of Arkansas crops**Issue**

Foliar diseases of soybean and corn are widespread and reduce growers' profits by decreasing yields and increasing costs associated with disease management. Two important diseases in Arkansas, frogeye leaf spot of soybean and grey leaf spot of corn, are caused by related fungal pathogens that share many similarities. The recent discovery of fungicide resistance among pathogen populations in neighboring states could further increase the impact of these diseases on Arkansas agriculture. New sources of genetic resistance are needed to counteract potential changes among pathogen populations associated with fungicide resistance and the emergence of new, highly virulent races.

Action

The recent completion of the Human Genome Project has offered unparalleled insights into human diseases. In an analogous approach, we are sequencing the genomes of the fungal pathogens that cause grey leaf spot and frogeye leaf spot with the goal of identifying and characterizing specific fungal genes that are critical for disease. We recently discovered and characterized a fungal gene that is required for the early stages of leaf infection. Without this gene, the pathogen is unable to enter leaves and thus disease symptoms are virtually eliminated. This discovery provides a critical tool from which we can further understand how these pathogens cause disease.

Impact

Sequencing the pathogen genomes will allow us to identify biochemical mechanisms that occur when infections trigger plant immune responses (resulting in disease containment), as well as ways in which the pathogen overcomes plant defenses (resulting in disease and plant death). This information will improve current breeding efforts to improve genetic resistance and could potentially identify new fungal targets to control the diseases. All of the information generated from this work will be publicly accessible so that researchers from around the world can use these resources for their own efforts to find solutions for these important diseases.

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Funding

Funding for this work is provided by the National Science Foundation, the U.S. Department of Energy Joint Genome Institute Community Sequencing Program, African National Research Foundation; University of Arkansas Division of Agriculture.

Conventional cotton variety combines early maturation, competitive yields and exceptional fiber quality

Issue

For at least 10 years, essentially all of Arkansas cotton has been planted to transgenic varieties. Now, the advent of glyphosate-resistant weeds has lowered the value of some transgenes. A competitively high yielding, early maturing, conventional variety is needed as an alternative for producers wanting to reduce seed technology costs. Since the varieties best adapted to Arkansas generally do not have outstanding fiber quality, marketing of Delta-grown cotton suffers in tight market conditions. By improving fiber quality, Arkansas cotton producers will have a competitive edge over other cotton production areas.

Action

The variety 'UA48,' released by the Arkansas Agricultural Experiment Station in 2010, is a conventional early maturing one that produces competitive yields in Arkansas and possesses exceptional fiber quality. In replicated tests over the past four years, UA48 has produced lint yields equal to 'DP393,' a well-adapted conventional variety that is no longer available. The UA48 variety was the earliest maturing in both the 2009 and 2010 Arkansas Cotton Variety Tests, and appears to be best adapted to silt loam soils in the northern cotton belt. In most tests, UA48 produces significantly longer and stronger fibers with higher length uniformity than any other entry. Micronaire of UA48 is comparable to DP393 and many other adapted varieties. A limited amount of seed of UA48 from a 2010 west Texas seed increase will be available in 2011. Further information on UA48 is available at <http://aaes.uark.edu/UA48.html>.

Impact

In the short term, UA48 will provide an alternative for producers who wish to grow a conventional cotton variety. A longer term impact may be the influence of UA48 on cotton variety development. The performance of UA48 demonstrates that early maturation and enhanced fiber quality can be combined into a well-adapted cotton variety for Arkansas. The UA48 variety sets a new standard for combining early maturation, competitive yields and exceptional fiber quality. The new standard may encourage the development of additional varieties that will further enhance the competitiveness of Arkansas-grown cotton.

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Funding

Cotton Incorporated; University of Arkansas
Division of Agriculture

Fighting herbicide-resistant ryegrass in wheat

Issue

Ryegrass is a major weed problem in wheat production. It

has evolved resistance to diclofop; the ALS herbicides mesosulfuron and penoxsulam; and the relatively new ACCase herbicide, pinoxaden.

Action

Our research methods include annual testing of suspect populations using all potential ryegrass herbicides in wheat, comprehensive sampling and surveying of ryegrass populations in Arkansas to determine the resistance profiles based on bioassays and gene sequencing experiments, and development of in-season detection techniques of resistant ryegrass using an agar-based bioassay method (RISQ).

Impacts

The University of Arkansas was selected by Syngenta Crop Protection to conduct the pilot study of Resistance In-season Quick (RISQ) test for testing ryegrass resistance to pinoxaden. This test enables growers to evaluate the level of resistance in the field early in the growing season, in time for early post-emergence herbicide application. The pilot study covers various wheat growing states in the U.S.

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Funding

Dow AgroScience; Syngenta Crop Protection; Arkansas Wheat and Promotion Board; University of Arkansas Division of Agriculture

Understanding the impact of Clearfield rice technology on weedy (red) rice populations

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™ rice. This technology underscores the gene flow issue between rice and weedy rice and potential problems that can arise.

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 are being analyzed to determine evolutionary divergence. Red rice growing in Clearfield rice fields were also sampled to study the impact of outcrossing on the weedy populations

Impact

Growing knowledge about the morphology, phenology,

seed dormancy, and genetic diversity of red rice in Arkansas is helping refine weedy rice management recommendations. Growers are now more aware about gene flow between rice and weedy rice, and the resulting morphological diversity in subsequent population of outcrosses. Comprehensive research on red rice resulted in two Federal Grants: one from NRI, in collaboration with the University of California, Davis and Clemson University; and one from NSF in collaboration with the University of Massachusetts, Washington University, and the DBNRRRC USDA-ARS at Stuttgart, Ark.

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Funding

USDA CSREES-NRICGP; NSF; 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 sulfentrazone + carfentrazone (Spartan® Charge) was approved under section 24c for cowpea in Arkansas. This provides growers with a better option for preplant herbicide application in cowpea involving a premix of sulfentrazone and carfentrazone. 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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Allen Canning Co.; IR-4; FMC Corp; 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 production 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, soysause, miso, soynuts, edamame, and bean sprouts. A new breeding program has been initiated at the University of Arkansas in 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 nutraceuticals, and therefore enhance the overall soybean production.

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

Genetic diversity offers new genes for soybean improvement

Issue

Pedigree analysis and molecular data show that the genetic base of southern soybean is extremely narrow. Studies have demonstrated that 80% of the genes in public soybean cultivars came from only 13 ancestral lines. The rate of yield gain has been limited somewhat in the south in the past 20 years and lags significantly behind that of the north. The lack of diversity limits breeding progress for improving yield and adaptation.

Action

Our recent research has identified a number of plant introductions (PI) and lines from other production regions that have reasonable yield and desirable diversity. We have crossed some of these PIs, as well as elite lines from the north, to southern elite cultivars and lines. We have developed populations and lines from these crosses with 50% exotic pedigree. These bridge materials will serve as the new gene pool for future yield improvement of southern soybean. The next step of this diversity enhancement program will focus on intercrossing among the intermediate lines derived from elite \times exotic crosses. This process will allow for further genetic assortment, segregation, and recombination, thereby generating even more diverse recombinant inbred lines with high levels of genetic diversity and adapted genetic background. This type of crossing scheme involves two different exotic lines and two unrelated adapted lines in each cross combination, and would allow the progeny to rapidly approach genetic homozygosity for pure line selection and provide more opportunities to obtain transgressive segregants.

Impact

Improving yield potential of soybean is essential to producer profits and high yield is achieved by specific adaptation of varieties to production environments. Improved yield comes from improved adaptation to Arkansas environments which are defined by a wide range of planting dates (late March to early July), crop rotation systems, stresses (drought to flood), soil types, and pests. Thus, improving adaptation requires genetic diversity for stress tolerance, diverse maturity, pest resistance, as well as other agronomic and quality traits. All desirable traits must be moved into high-yield lines to impact long-term Arkansas soybean production. This research project identifies lines with a diverse gene pool for yield, increased adaptation, stress tolerance, pest resistance, quality attributes, and genetic diversity in general. These lines are the essential fuel for successful yield improvement. The improved lines can be used by the University of Arkansas and other

breeding programs, thereby allowing breeders to continuously improve the yield potential of new varieties. Basic research on genetic diversity in public institutions is essential and extremely important because private companies tend to neglect this long-term research investment. The germplasm identified and developed under this objective will greatly enhance the efficiency of public and private breeding programs that aim to improve soybean productivity and profitability.

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United Soybean Board and Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture

Prime-Ark® 45 blackberry broadens commercial harvest season

Issue

America's domestic blackberry production for the fresh market has increased substantially in recent years. Blackberries are a common item on grocery store shelves, where in recent years they were seldom present. Improved summer fruiting (florcan-fruiting) cultivars contributed substantially to the blackberry industry expansion. However, there has traditionally been a gap in fruit availability between summer-fruiting domestic cultivars and the beginning of imported blackberries from central Mexico in November. The newly introduced primocane-fruiting blackberry (potential fall fruiting) by the University of Arkansas allows for blackberries to be produced until fall temperatures terminate production.

Action

The University of Arkansas fruit breeding program has been improving 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, florican-fruiting blackberry varieties has been released including Ouachita, the most widely planted of the Arkansas developments. 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. The release of Prime-Ark® 45 in late 2009 provided for a shipping-quality cultivar choice for late-season production for the first time in the history of blackberry production in the U.S. Nearly 300,000 plants of this new variety were planted in commercial fields in early 2010 to begin the post-summer fruiting blackberry production era.

Impact

The planting of Prime-Ark® 45 will expand grower profits and consumer quality choices for domestically produced blackberries. Since market prices are normally higher in late summer and fall, growers should achieve a premium price for their berries. Specialty crop grower profits, consumer needs, and overall enhanced nutrition are being served by the genetic advances of Arkansas-developed blackberries.

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Funding

University of Arkansas Division of Agriculture;
Fruit variety royalties

Jupiter grape expands Eastern and Pacific Northwest U.S. table grape production

Issue

Table grapes provide one of several fresh-fruit options for local-market fruit growers. In the eastern U.S., *Vitis vinifera* table grape cultivars are not adapted and cannot be grown reliably. This results in very few cultivar options for eastern growers. The addition of table grapes to these markets can help diversify grower and consumer choices. Grapes with expanded flavors, increased winter hardiness, and overall plant adaptation are the basis for this expanded fruit production option.

Action

The University of Arkansas fruit breeding program undertook table grape improvement beginning in 1964. Major objectives for improvement included seedlessness, non-slip-skin texture, winter hardiness, fruit cracking resistance, and improved plant health. Cultivars introduced include Venus, Reliance, Mars, and Saturn. The newer introduction Jupiter offers much-improved fruit quality and exhibits good adaptation in the challenging environments of the mid South, Midwest and northeastern U.S. Its non-slip-skin texture, seedlessness, and exceptional muscat flavor are leading to this expansion. Further breeding and testing is providing for an expanded cultivar profile for growers in the coming years.

Impact

Increased plantings of Jupiter in a range of states in the east and Pacific Northwest are being made. The exceptional fruit quality is exciting for growers and consumers. This is leading to expanded diversification in fruit plantings for local markets which often had limited cultivar choices for table grapes. Consumers are being provided with a top-quality fruit with exciting flavor for enjoyment and health enhancement.

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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 that 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.

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Arkansas Soybean Promotion Board; University of Arkansas
Division of Agriculture

Identification of new races of the spinach downy mildew pathogen in the United States and development of molecular markers linked to disease resistance

Issue

Downy mildew of spinach is the most economically important disease of spinach worldwide. Accurate identification of races of the pathogen is critical to aid in developing cultivars with resistance to the various races and aiding in global communication regarding the occurrence and frequency of downy mildew races.

Action

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. Two lines have been developed and seed of these lines have been released.

Impact

As a result of this research effort, our laboratory has identified 6 of the 10 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. As a result of this effort, we were invited to write an overall review of the state of the art of disease resistance in spinach.

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Funding

University of Arkansas Division of Agriculture

The molecular diversity of the rice blast pathogen and the 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 characterize 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*.

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. In addition, isolates are being recovered from newly released hybrid rice lines to determine if the blast pathogen has specifically developed specificity to these new rice genotypes.

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Funding

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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 very much needed. One way 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 which 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.

In 2010, six additional cultivars were observed to provide extension of the model to a number of different rice cultivars and eventually for all rice cultivars commonly grown in Arkansas. In addition, in 2010, experimental tests of the water-use predictions of the model were tested and confirmed.

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. In the future, the model will be extended to a wide range of rice cultivars.

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Funding

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

Evaluation of the COTMAN Program

Issue

The COTMAN Program is an in-season cotton crop information and monitoring system used to track physiological development and crop maturity to provide guidance on optimal timing of insecticide and defoliation applications, to improve economic returns and environmental sustainability. It has been available as PC software since 1994, designed for use by producers, consultants and researchers. A need has arisen to assess the strengths and weaknesses of COTMAN from the user's perspective regarding barriers and incentives for adoption, assess usability, identify educational and support needs, and to direct efforts for future software development and delivery.

Action

A study using two focus groups (consultant COTMAN users and consultant COTMAN non-users) was conducted in January 2010. Both groups (six participants per group) were asked to respond to open ended questions framed to introduce the topics of 1) barriers and incentives to adoption, 2) software usability enhancements, 3) education and support needs and 4) future software/hardware development directions. Consultants were characterized by geographic location, years of experience, number of clientele, clientele acreage and years of experience with COTMAN. Qualitative responses to the following questions were summarized and compared between groups. What are incentives to use COTMAN? What are barriers to using COTMAN? What are useful production management software functions? Is COTMAN missing important functions or features? Does COTMAN have features not needed? What aspect of COTMAN needs most improvement? What is the best way to support COTMAN or production management software? Are software tools other than COTMAN used? How likely are you to use COTMAN in the future?

Impact

While the focus group study results cannot be used as estimates of a population response, they do provide invaluable information on the scope of problems and prospects for enhancing the development and usefulness of COTMAN. The responses indicated that improvements are needed to expand adoption and use of COTMAN. Enhancements to data collection, hardware, weather tracking, and reporting of results are needed. More training and field level support are needed. With improvements all respondents indicated that they would be interested in potentially using COTMAN. Enhancing COTMAN will result in better informed decision-making and management of cotton production in the United States. Improved efficiency in use of costly insecticides and defoliant will reduce costs of production, increase yields and result in higher profitability for cotton producers, making U.S. cotton more competitive in domestic and global markets.

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Funding

Cotton Incorporated; Arkansas Agricultural Experiment
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Hybrid rice breeding

Issue

Over the past decade, commercially bred hybrid rice seed has become competitive with conventional, inbred varieties developed at public institutions. In Arkansas, hybrid rice was grown on about 28% of the rice acreage in 2010. In light of this major shift in seed sales, it is logical for the University of Arkansas Division of Agriculture rice breeding program to begin the development of hybrid varieties.

Action

Preliminary work was begun on the development of male-sterile lines (both cytoplasmic male sterility, CMS, and environmental male sterility, EMS), maintainer lines for CMS, and restorer (R) lines. In the winter of 2009-2010, 1278 crosses between diverse accessions and known maintainers were grown out to develop new MS sources. These crosses yielded 404 F2 populations that were evaluated in the field in 2010. Crosses between U.S. varieties and known restorers (China, IRRI) were evaluated in 3,395 F3 panicle rows in the winter of 2009-10, yielding 1,565 F4 panicle rows for evaluation in the field in 2010. There were 514 new crosses made in the field. A test of F1 hybrid seed production was made between 11 MS lines and 10 restorers. Seed from these combinations will be evaluated in yield plots in 2011.

Impact

It is far too early in the breeding program to assess the impact of these particular crosses and tests. However, they represent a good start in a long-term program to develop hybrid varieties in cooperation with public breeding programs in Louisiana, Texas, Missouri and Mississippi

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Funding

State of Arkansas General Revenues; Arkansas Rice Research
and Promotion Board; University of Arkansas Division of
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Economic decision making and planning guides for 2011 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 has revised 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 cost and return 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.

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
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Funding

University of Arkansas Division of Agriculture

Economic analysis of crop research verification program reports

Issue

Results reported for the Crop Research Verification Program (CRVP) include a section for economic analysis. Coordinators of the CRVP from the Department of Crop, Soil, and Environmental Science (CSES) seek to revise the published documentation for the program results.

Action

Faculty from Agricultural Economics and Agribusiness (AEAB) and CSES meet to discuss manuscript revisions. The crop enterprise budget calculator was developed to generate tables that meet specifications established by the CRVP coordinators. Also, there is a template to report economic analysis for all crops in the CRVP.

Impact

Reports of the CRVP are published that include the most relevant economic information for utilization by clientele. Document publications are now standardized for all CRVP crops.

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

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

United States 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 the 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

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

Characterization of mechanisms of plant defense against aphids

Issue

Nearly all of the world's major crops are attacked by at least one species of aphid. These insects extract sap from the phloem or vascular tissue of plants using slender, syringe-like mouthparts that can penetrate between plant cells to reach the phloem. Aphids transmit plant diseases in addition to siphoning off sugars and amino acids from the plant, and controlling these pests is often complicated by pesticide resistance. Selection for cultivars that are resistant to aphids represents the most effective, economical, and environmentally safe means of controlling aphid pests. However, our ability to utilize host plant resistance to manage aphids is limited by our inadequate knowledge of the types of plant traits that can inhibit aphid infestations.

Action

Working with a form of resistance to the potato aphid (*Macrosiphum euphorbiae*) that was previously identified in tomato (*Solanum lycopersicum*), we investigated the mechanism of resistance by using the direct-current electrical penetration graph technique (DC-EPG) to compare aphid feeding behaviors on nearly isogenic resistant and susceptible plants.

Impact

Our results demonstrated that aphids took longer to find an appropriate feeding site in the phloem of the resistant tomato cultivar compared to susceptible plants. Furthermore, as the aphids' mouthparts penetrated the plant intercellularly, aphids on resistant plants were slower to initiate cell sampling. These data indicate that factors in the intercellular spaces of resistant plants inhibit the aphid feeding process. This insight expands our understanding of plant defenses against aphids, and should assist in identifying biochemical traits that can reduce aphid infestations.

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Funding

USDA-NRI Competitive Grants Program; University of Arkansas Division of Agriculture

Developing an inexpensive trap and lure for green June beetles

Issue

From July to early August, adult green June beetles often mass attack and destroy ripening fruit of apple, blackberry, corn, grape, peach and raspberry. Most insecticides cannot be used against the green June beetle due to the potential for toxic residue on harvested fruit. Thus, we are developing an inexpensive trap as an alternative protective tactic to insecticides.

Action

In July and early August, our efforts in Green Forest, Arkansas, along with work with cooperators in Mountain Grove, Missouri, compared the relative attractiveness to green June beetles of differently colored traps placed at different heights and baited with different release rates and percentage concentrations of isopropanol (rubbing alcohol). We tested a low-cost trap to detect presence of June beetles, made of a 2-liter, clear beverage bottle, hung upside down at two foot height above ground, baited with a 60% isopropanol solution.

Impact

Commercial fruit growers and backyard fruit producers can build their own traps for as little as \$2.50 per trap per season. These simple traps can be set out in late June and detect first dispersal of green June beetles toward fruit plantings. This will alert the grower to check the fruit planting for green June beetles and selectively apply insecticide sprays. In the future, we hope to have further developed this system to mass attract and kill green June beetles at the perimeter of a fruit planting.

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Funding

USDA/NIFA OREK Small Business Innovation Research Award No. 2010-00204; Southern Region Small Fruit Consortium and Southern Region IR-4 Award No. 2010-11; University of Arkansas Division of Agriculture

Impact of the Corn Research Verification Program

Issue

Corn acreage has expanded in Arkansas in the past few years as corn grain prices have risen and producers see the benefit of including corn in their crop rotations. With the increase in acreage and increasing number of producers that are growing corn (many for the first time), there is a great need to educate county agents and producers on how to grow high yielding profitable corn.

Action

The Arkansas Corn Research Verification Program serves as an educational tool to educate county agents and producers about up-to-date management practices for growing corn in Arkansas. The program takes Arkansas generated research and demonstrates it on a whole-field basis. The program begins the fall before corn is to be planted. The verification coordinator and county agent sit down with the producer and discuss hybrid selection, field selection, fertility needs for the field, seeding methods, and any other issues that may arise during the growing season. Once the corn is planted, the coordinator and agent make weekly visits to the field to monitor crop progress and prescribe any inputs that the crop may need. The producer also walks the field with the coordinator and agent to learn firsthand. The producer is asked to keep track of all inputs that are applied to the field so that an economic analysis can be performed at the end of the season to determine profitability of the field.

Impact

In 2010, following University of Arkansas corn production recommendations for hybrid selection, fertility management, weed and insect control, and irrigation management, corn producers in the verification program were able to reach maximum yields. Yields in the verification program averaged 204 bu/acre, which was the second highest average yield the program has ever had. The state average corn yield was 150 bu/acre. The high yields in the verification program were due to proper hybrid selection, planting rates, adequate fertility, weed control, and irrigation. The drought of 2010 showed that irrigation is very important. With proper irrigation and management, verification fields yielded 54 bu/acre more than state average fields: $54 \text{ bu/acre} \times \$5.00/\text{bu} = \$270/\text{acre}$ gain in gross revenue compared to state average fields. This shows that Arkansas corn producers can grow high yielding profitable corn following University of Arkansas Cooperative Extension Service recommendations.

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Cooperators

Various county agricultural extension agents and corn producers in Arkansas

Funding

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

Providing soybean producers with criteria to select an appropriate resistant cultivar

Issue

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 Arkansas' 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. Since the two most critical criteria for selection of soybean cultivars for planting by Arkansas farmers are: i) yield potential and ii) disease resistance, a mechanism to evaluate new cultivars for disease resistance as well as yield is needed.

Action

Our comprehensive annual program evaluates all cultivars in the OVT each year for resistance or susceptibility to most of our 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

Arkansas produces 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

Impact of nematodes and seedling diseases on cotton production and profitability

Issue

Cotton is the most important agronomic crop in the southern U.S. with an estimated annual value of approximately \$6 billion. In Arkansas, about 10% of the cotton crop is lost to diseases each year, and seedling pathogens and nematodes account for over half of those losses. Two pathogens, the root-knot nematode and *Thielaviopsis basicola* are widespread throughout the production areas of the state. Each pathogen produces characteristic effects on cotton roots: the root-knot nematode causes root galls to form on all parts of the root system, while *T. basicola* causes loss of root cortex, resulting in damage or total loss of the taproot. Since both pathogens can alter the size and shape of the roots and impair the functionality of the root system, they can be of major impact in field situations where physical impediments to optimum crop production such as the presence of a compaction layer or hardpan is also present. To date, no investigations have been conducted to determine the combined impact of these pathogens and a hardpan on cotton root architecture nor has anyone studied their combined effects on cotton growth, development, and yield. 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.

Action

Studies are underway to evaluate the impact of nematodes, *T. basicola*, and a compaction layer in the soil on the architecture of cotton roots as they develop throughout the season. We are using experiments in microplots and in field plots to i) quantify and describe the changes in cotton root system architecture that result from infection by root-knot nematodes, *T. basicola*, and a compaction layer singly and in combination and ii) the relationship between these root architectural changes and crop development and yield.

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 and focus additional attention on the need for effective resistant cultivars for the mid-South. 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

Identifying rice genes ‘turned on’ by insect damage

Issue

Like virtually all plants grown for human food, rice plants also serve as food for insect pests. Although plants do exhibit multiple natural ways to defend themselves from insects, these mechanisms are often not active at levels that prevent economic or production losses in agricultural settings. Losses to insects and the costs of controlling insect pests can result in major economic setbacks for growers.

Action

As a means to better understand the natural defense capabilities of rice plants, we set out to identify changes that occur in the plant when insects feed on leaves. Plant genes involved in defense against pests will very often be regulated resulting in high levels of specific gene expression. We applied the very latest technologies of “next generation” DNA sequencing to identify genes in rice plants that respond to insect feeding. Both beet armyworm caterpillars and rice water weevil adults were allowed to feed on small rice plants in the greenhouse. After the plants were damaged for several days, we collected the plant tissue and compared gene expression in these plants with non-damaged plants. Working in collaboration with scientists at Ohio State University and the University of Delaware, we created a large gene sequence computer database showing the thousands of rice genes that respond to insect feeding.

Impact

The large gene database that has resulted from this work will serve as a valuable resource for researchers of rice and insect defenses worldwide. Specific rice genes that respond to insect feeding serve as good candidates for further study and incorporation into varieties with enhanced insect resistance.

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Funding

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

Vector control strategy to manage barley yellow dwarf in wheat

Issue

Widespread infections of the barley yellow dwarf virus (BYDV) in the fall can lead to serious yield losses in winter wheat in Arkansas. Pesticide industry and some pest managers suggest that control of aphid vectors reduces the incidence of barley yellow dwarf. However, low disease incidence and narrow profit margins preclude frequent insecticide applications for aphids in Arkansas. Previous research documented that single, carefully timed applications reduced aphid infestations throughout the fall and winter in northern, but not central or southern Arkansas. New seed treatments are considered more effective and do not require the careful timing of application which limits treatment effectiveness. The bird cherry oat aphid is the predominant vector of BYDV in Arkansas and arrives in the field at various times in the fall. Research is needed to determine if these new seed treatments provide adequate vector control sufficient to reduce BYDV incidence in light of the number of immigrant aphid flights.

Action

Tests were conducted in early-planted, fall-sown wheat in northwest Arkansas in 2009 and 2010 to closely evaluate the efficacy of new seed treatments. Paired one-quarter acre plots (treated and untreated) were established and aphid numbers were evaluated twice weekly from plant emergence until mid winter when immigrant fall aphid flights ceased. The frequency of immigrant aphids was estimated by observation of winged aphids in plant samples and from yellow pan traps commonly used to sample winged aphids.

Impact

In both years the insecticide-treated seed provided significant, long-term reduction of aphids in wheat in the northern portion of the state where immigrant aphid flights were restricted to the first two weeks of crop emergence. Although few flights of immigrant aphids were observed after this two-week period, aphids that alighted on treated plants had a similar survival rate to those alighting on untreated plants. Our previous research documented variable insecticidal control in the central third of the state, providing adequate control only during years with colder fall and winter months. We suspect that even highly efficacious seed treatments appear to be of little value in southern Arkansas counties due to the frequency of winter aphid flights in the warmer climate. This study and our previous research suggest that because of low disease incidence in a typical year, most Arkansas wheat producers, even those in the northern areas of the state, would realize little to no gain from control of aphid vectors of BYDV with seed treatments. This recommendation suggests growers may avoid the expenditure of more than \$15 per acre for a seed-applied insecticide treatment. In spite of this recommendation, we expect growers will continue to plant insecticide-treated seed if they suspect a particular field will be prone to BYDV infection.

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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 in U.S. production areas 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. Impacted by field conditions, inherent field resistance is expressed after the plant becomes diseased and functions to limit or prevent disease progress. When rice blast is controlled via field resistance, modern susceptible varieties typically out-yield R-gene resistant varieties by 5-10%. Growers manage field resistance using various cultural practices to lessen the occurrence and impact of diseases. 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 disease free 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. Continued research into the mechanism of flood induced field resistance has identified root zone dissolved oxygen (DO) as the mediating variable for blast field resistance mechanisms. Dissolved oxygen content defines availability of plant nutrients and root production of hormones, primarily ethylene, which determine susceptibility to rice blast. Plants grown in flooded conditions have well organized leaf vein vascular bundles which inhibit fungal growth. Drought stress compromises efficacy of R genes, such as *Pi-ta*, currently utilized in Arkansas and other rice producing states. 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.

Impact

Grower acceptance of recommended fertility, irrigation and disease scouting practices based upon these scientific con-

cepts and results have reduced disease incidence and severity.

Proper irrigation is 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 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 traditional R gene resistant varieties and yields often compare with hybrid cultivars. At an estimated value of \$5 per bushel, this additional yield provides approximately \$25 to \$150 increased per acre income in over 50% 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. Although identified in 1993, a potentially damaging blast race, IE-1k, was held in check in susceptible varieties by root zone induced field resistance until 2004 when the Banks cultivar was released. Although all Arkansas varieties are susceptible to blast race IE-1k, the disease does not occur in these varieties when grown in flooded conditions.

In addition, field resistance is a quantifiable inheritable characteristic. Significant long-term benefits will accrue as plant breeders select for this highly desirable characteristic 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 ones, 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

Fertilization and herbicide application increases mid-rotation loblolly pine production

Issue

Fertilization and herbicide applications are common practices used to increase productivity of loblolly pine plantations. Herbicide application is frequently used during pine plantation establishment while fertilization is most often used later in the life of the stand following the first commercial thinning. Many landowners and forest managers in Arkansas are interested in whether the combined application of herbicide and fertilizer to mid-rotation loblolly pine stands can significantly increase yields above those observed from only an application of herbicide or fertilizer alone.

Action

Researchers within the Arkansas Forest Resource Center and forest managers with the Plum Creek Timber Co. collaborated to assess the impacts of a combined fertilizer and herbicide application in the Upper Gulf Coastal Plain of Arkansas and Louisiana. Applications of fertilizer (urea+diammonium phosphate) and imazapyr herbicide were separately and in combination applied to different locations in five loblolly pine stands (16-17 years old). Tree height, diameter at breast height (dbh), total volume, merchantable volume, and chip and saw volume was monitored for six years following the applications.

Tree growth within these areas was compared to portions of the stands where fertilizer and herbicide was not applied to assess the response to treatment application.

Impact

This study indicated that volume growth was generally greater with the combined application than with either of the individual applications. Merchantable and chip and saw volume growth with the combined application was respectively 17% and 22% greater than with the herbicide-only application and 13% and 17% greater than the fertilizer-only application. The increased volume growth of the combined fertilizer and herbicide application appeared to be a result of the differences in how herbicide and fertilizer alters tree height, diameter at breast height, and basal area growth. The imazapyr application increased basal area growth by reducing competition from hardwood trees but reduced height growth by injuring the terminal buds present at the time of the application. Fertilizer application tended to increase dbh and height growth, but mortality of the pine was increased in comparison with the herbicide-only or combined application. The combination of the two applications together tended to offset the negative impacts observed with the herbicide- or fertilization-only applications. Thus forest managers and landowners should be able to realize optimal yields from mid-rotation stands by combining fertilizer and herbicide applications.

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Funding

Plum Creek Timber Co.; University of Arkansas
Division of Agriculture

Disseminating new *Sinningia* hybrids

Issue

Sinningia is a genus of plants primarily found in Brazil. Related to the houseplant African violet (*Saintpaulia*), *Sinningia* hybrids are best-known as the florist's gloxinia. However, many other species are used in hybridization and hobbyists actively produced desirable hybrids. Due to relatively slow propagation by conventional means, these hobbyist-produced hybrids often fail to reach a wider gardening public and are thus not evaluated under different growing conditions or in different climates.

Action

Single plants of two newly released *Sinningia* hybrids 'Minnesota Nice' and 'Prudence Risley' were obtained from cooperators. 'Minnesota Nice' was awarded the best recent gesneriad hybrid in 2008 by the Gesneriad Hybridizers Association. 'Prudence Risley' is popular in a small section of gesneriad growers due to its long flowering period and its red flowers. Many current growers are enthusiastic about this hybrid's potential as a container plant for home gardeners. Neither hybrid is widely available commercially. To produce

plants for widespread evaluation, in vitro cultures of each were successfully initiated and correct protocols for shoot multiplication established. Shoots were rooted into plug trays and rooted plugs shipped to cooperators in Pennsylvania.

Impact

Over two hundred tissue culture plugs were produced from these two recently released hybrids. Cooperators in Pennsylvania will grow these plants to flowering size and these plants will be made available at the Gesneriad Society's 55th Annual Convention in 2011. Success of this project may result in other hobbyists offering their new crosses for propagation and subsequent wider distribution.

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Liberty Bell Gesneriad Society; National Capital Gesneriad Society

Funding

University of Arkansas Division of Agriculture; Delaware African Violet, Liberty Bell and, National Capital Gesneriad Societies

Insects of stored rice in northeast Arkansas

Issue

Rice is one of the most widely grown cereals in the world and is grown in over 100 countries. It is a major crop of the United States, with two primary areas of production: the Sacramento River Valley in California, and in the Mid-South which includes Arkansas, Louisiana, Mississippi, Missouri, and Texas. The U.S. rice market greatly depends on the quality of the rice produced. One important factor that can influence quality is insect infestations. Insect pests of stored grains, including rice, can be grouped into primary internal and secondary external feeders. Internal feeders are those insects where the immature stage feeds internally within the kernel. They can also attack high quality grain where the kernel is intact and the grain contains optimal moisture. One example of a primary pest is the lesser grain borer [*Rhyzopertha dominica* (F.)]. This cosmopolitan pest takes approximately one month to develop under typical U.S. summer conditions. Secondary stored pests feed externally in the immature stage and develop outside of the kernel. Examples of the secondary pests include the Indian meal moth, cigarette beetle, and warehouse beetle. There have been many studies conducted on stored-product insects in wheat. Recent studies show that the lesser grain borer can move and disperse from refugial areas into areas where wheat is stored. There are no corresponding studies of stored-product insects in and around sites where rice is milled and stored.

Action

A study was conducted at a rice mill in northeast Arkansas to monitor the population dynamics of various stored-product insects that can infest rice. Delta glue traps were set out at the

rice mill and hung approximately 1 m above the ground. The traps were dispersed around the perimeter of the property and around each major building of interest. No traps were placed inside the facility. The traps were collected weekly during warm summer temperatures. As the temperatures began to fall, the traps were changed out every other week. During the winter months, traps were collected every four weeks, until the temperatures began to increase again in spring.

Impact

This study will result in a better understanding of the seasonal and spatial patterns in flight activity of stored rice insects. This information could improve the ability to predict where and when invasion from outside is important.

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Funding

United States Department of Agriculture; University of Arkansas Division of Agriculture

Development and implementation of integrated pest management programs for Insects on Arkansas vegetables

Issue

Insects affect snap bean, squash, egg plant, spinach, greens and cowpea, which are the more important commercially produced vegetables in Arkansas. Management of these insect pests was previously based on insecticide applications when plants reached specific developmental stages, regardless of presence of insects. Little to no effort at scouting for insects was made in Arkansas vegetable crops. As a result insecticides were sometimes applied when no insects were present or when the least susceptible insect stages were present. That management approach increased costs of chemicals (\$5 to \$10 per acre) and application (\$3 to \$5 per acre). Multiple applications per cropping season increased these costs further. Additional problems associated with this strategy included increased applicator exposure to chemicals, potential environmental hazards, and the potential for insects to develop resistance to synthetic chemicals.

Action

Recent field studies demonstrated the effectiveness of new insecticides against insects on pepper, eggplant, cowpea, and sweet corn. An older organophosphate insecticide, acephate, has been shown to increase blooming in cowpea. Application of acephate or imidacloprid to cowpea seed has the potential to reduce grower costs and provide excellent insect management. Studies of thrips on cowpea have shown that feeding on seedlings or blooms by thrips does not affect cowpea yield as much as previously thought. Sampling techniques and thresholds have been developed and are currently in use in western Arkansas, northeast Oklahoma and southwest Missouri for corn earworm larvae on snap bean. Studies have also produced an acceptable method for detection of European corn borer

larvae in snap bean seedlings (plant flagging) and adult European corn borers with pheromones in traps. 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

Alternatives to foliar insecticide sprays for aphid management on spinach are now available and are in use in the Arkansas River Valley. Strategies are now in place to efficiently manage the corn earworm and European corn borer in spring snap bean in the three-corners of Arkansas, Missouri and Oklahoma. Growers of snap beans using these recommendations reduced insecticide use by about 40% with no reduction in snap bean quality. Results showing little damage by thrips reduced insecticide applications in cowpeas. Squash and pumpkin producers now have a method of managing squash bug. Additional benefits include reduced exposure to insecticides and reduced environmental hazards.

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Funding

Allen Canning Co.; Chemical Cos.; 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 University of Arkansas 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 work-

ing 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

Twenty-four percent of the rice grown in Arkansas in 2010 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 6,300 lbs/acre in 2010. Assigning a conservative value of 60% of this 2,190 lbs/acre yield increase to new varieties, the average monetary gain in 2010 over 1980, at a rough rice price of \$9.60/cwt, would be \$210/acre or \$353 million for the 1.681 million acres grown in Arkansas, of which \$85 million is due to the Arkansas varieties.

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Funding

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

Assessment of the bio-control product (Afla-Guard) for suppression of aflatoxin production in corn

Issue

Aflatoxin contamination remains the most important disease-related problem in Arkansas corn production, affecting certain growers each year. Once contaminated, there is no easy or practical answer for dealing with the grain, from the standpoint of the farmer. So preventing aflatoxin contamination is the key. Since the threshold level for aflatoxin is 20 ppb, it only takes a small amount of highly contaminated grain—such as from a small, stressed area within the field—to contaminate an otherwise healthy load of corn. Aflatoxin can reduce the value of corn from 50–100%, depending on the supply of corn in the U.S. and market conditions. And it can affect up to 50% of the Arkansas corn acreage in epidemic years like 1998, when aflatoxin cost our growers an estimated \$15,000,000 in direct losses.

Action

Multiple field trials on private farms in White and Clay Counties and on a private farm and at the Newport Research Station in Jackson County were used to determine efficacy (and practicality) of applying the microbial antifungal crop protection product Afla-Guard in reducing aflatoxin develop-

ment. Afla-Guard will be tested in both a naturally occurring and inoculated plot with *Aspergillus flavus*. Afla-Guard applications will be made at silking (suggested timing) and prior to the inoculation of *Aspergillus flavus*. Multiple samples of grain from each plot area will be collected and analyzed for aflatoxin and fumonisin to determine overall efficacy of Afla-Guard.

Impact

Initial results were positive from all of the trial locations in which Afla-Guard did reduce levels of aflatoxin. Results from one of the Jackson County locations showed that all areas treated with Alfa-Guard had no aflatoxin detected where as all untreated areas had moderate to high levels of aflatoxin ranging from 45 to 844 ppb.

Utilization of the microbial antifungal crop protection product Afla-Guard at this location allowed the producer to sell his corn without penalty or rejection (70 acres, 185 bushels at \$4.25/bu). A potential savings to the farmer of \$55,037.50 if the field had not been treated and corn was rejected. If you account for the 10% of the 390,000 acres (150 bu/acre average) impacted by aflatoxin in 2010, a potential savings of \$5.85 million could have been achieved through educating producers on the correct usage of this microbial antifungal crop protection product Afla-Guard.

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

Improving corn potassium fertility recommendations in Arkansas

Issue

The renewed interest in biofuels has increased corn production in Arkansas. In 2009, more than 400,000 acres of corn were harvested in Arkansas. Potassium fertilization is a requirement to produce optimum corn grain yields. Improved soil-test based, K fertilization guidelines are vital for increasing growers' profit margins.

Action

Potassium fertility experiments were conducted at four sites on soils typical for corn production in Arkansas. Corn ear-leaf K concentration and yield response to application of 0 to 200 lb K₂O/acre in 40 lb K₂O/acre increments were evaluated in soils ranging from Very Low to Medium in Mehlich-3 extractable soil-test K.

Impact

Corn ear-leaf K concentration was significantly increased by K application at all sites except one site that had high surface soil-test K. Corn grain yields were significantly increased by K fertilization at all sites except one site where yields may have been limited by other factors. Compared to corn receiving no K, grain yields were increased by 12% to 60% by K fertiliza-

tion at the three K responsive sites. Yields were maximized by application of 40 or 80 lb K₂O/acre. Corn ear-leaf K concentrations at tasseling appear to be a good indicator of the K nutritional status of corn, and soil-test K appears to be a good indicator of soil K availability.

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Funding

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

Corn and cotton response to urea and an enhanced efficiency nitrogen fertilizer in Arkansas

Issue

Nitrogen (N) fertilization is often required for producing maximal cotton or corn yield in eastern Arkansas. Improving N use efficiency will increase the growers' profit margin and reduce potential environmental risks of excessive N application. Enhanced efficiency N fertilizers are developed to meet that dual need. Unfortunately, there is very little information on corn or cotton response to enhanced efficiency N fertilizers in Arkansas. Such information would be beneficial to Arkansas growers who may want to incorporate these materials into their overall N fertility management strategy.

Action

Two replicated field experiments were conducted to evaluate cotton response to urea and an enhanced efficiency N fertilizer each applied at 0-150 lb total N/acre (at 30 lb total N/acre increments). Another field experiment was conducted to evaluate the effect of the same N sources applied at 0-300 lb total N/acre (at 60 lb total N/acre increments) on corn.

Impact

Seedcotton yield at one site was affected by N source ($P = 0.0429$), but was not affected by N rate or N source \times N rate interaction. Averaged across N rates, cotton fertilized with enhanced efficiency N fertilizer produced numerically greater and statistically similar seedcotton yields as urea (2053 and 1932 lb/acre respectively). However, the yield of N-fertilized cotton was greater than cotton receiving no N (1264 lb/acre). At the other site, seedcotton yields were not affected by N source, N rate, or their interaction. Corn ear-leaf N concentration and grain yield were both affected by the main effects of N rate and N source but not by their interaction. Averaged across N sources, corn grain yield and leaf N concentration increased with each increase in N rate, except between 180 and 240 lb N/acre. Corn yield, averaged across N rates, was 12 bu/acre greater for corn fertilized with the enhanced efficiency N fertil-

izer than urea. The results suggest that enhanced efficiency N fertilizers provided equal or slightly higher N than urea to corn and cotton in 2010.

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Funding

USDA CSREES; University of Arkansas Division of Agriculture

Regulation of carotenoid synthesis in sweet potato

Issue

Orange-fleshed sweet potatoes are an excellent source of β -carotene (pro-vitamin A). However, they lack any significant amount of zeaxanthin, a carotenoid which accumulates in the retina, preventing age-related macular degeneration. Zeaxanthin is derived from β -carotene by the action of β -carotene hydroxylase. The aim of this study was to investigate the regulation of gene expression for key enzymes in the carotenoid pathway leading to β -carotene and zeaxanthin.

Action

Primers were designed for the amplification of the genes for phytoene synthase, lycopene β -cyclase, and β -carotene hydroxylase. Expression levels of these genes were determined by semi-quantitative polymerase chain reaction for both yellow- and orange-fleshed sweet potato cultivars. Carotenoid levels were determined by high performance liquid chromatography analysis and compared to levels of gene expression.

Impact

Yellow- and orange-fleshed cultivars differed tremendously in the levels of β -carotene. Neither type contained zeaxanthin. However, levels of gene expression for phytoene synthase, lycopene β -cyclase, and β -carotene hydroxylase were all high and essentially the same for both types. These results suggest that regulation of carotenoid synthesis is not occurring at the level of transcription, but by some post-transcriptional mechanism.

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University of Arkansas Division of Agriculture

Influence of midseason nitrogen application timing on rice grain yield

Issue

Direct-seeded, delayed flood rice (*Oryza sativa* L.) represents an important commodity for Arkansas and several other mid-south states in the U.S. Nitrogen fertilizer is applied to

virtually all rice and typically represents the largest economic input in rice production. Rice is quite responsive to nitrogen fertilizer and thus its proper application timing is important. Nitrogen fertilizer is applied to delayed flood rice in two split applications. The larger of the two applications is applied onto dry soil immediately prior to establishment of the permanent flood, termed pre-flood, and typically represents two-thirds of the total nitrogen fertilizer applied. The second application is made at the beginning of reproductive growth around beginning internode elongation or panicle differentiation. Research has not been conducted on proper timing of midseason nitrogen fertilizer on rice for about twenty years. Thus for new rice varieties, the best time to apply midseason nitrogen for the best yield response has not been studied.

Action

A multi-year study is being conducted to determine the proper time to apply midseason nitrogen fertilizer to the new rice varieties. The three new rice varieties chosen for the study are the semidwarf 'Cheniere', the short stature variety 'Taggart', and the hybrid rice variety CLXL745. Midseason nitrogen fertilizer was applied at three times: panicle differentiation (PD), seven days after panicle differentiation (PD + 7) and at PD + 14 days. Cheniere and Taggart, two conventional rice varieties, had a greater yield response to midseason nitrogen fertilization when it was applied at PD + 7 and 14 days compared to applied at PD. The hybrid rice variety, CLXL745, had similar grain yield response to all three midseason application timings. More years of data at multiple locations are needed to fully confirm the aforementioned results and to make a recommendation on moving the midseason application window to a week or two later.

Impact

If the above results are confirmed after more years of data collection, then the midseason nitrogen application time will be moved to a week or two later in the season and result in 10 to 15 bu/acre yield increase for conventional rice varieties.

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Funding

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

Sensitivity of soybean to imazosulfuron and halosulfuron

Issue

Imazosulfuron is a new sulfonylurea herbicide by Valent U.S.A that is to be registered for rice in 2011. Halosulfuron (trade name Permit) is the current standard of sulfonylurea herbicides used in rice. Soybean and rice are grown in close

proximity in Arkansas; therefore, it is essential to determine the sensitivity of soybean to imazosulfuron and halosulfuron. Currently, there is not much information available about drift of these two sulfonylurea herbicides to adjacent soybean fields. Knowledge of the sensitivity of soybean to imazosulfuron and halosulfuron drift is imperative for devising recommendations to minimize the impact of these herbicides on soybean.

Action

Two field trials, representing VC and V6 growth stages of soybean, were conducted in 2010 at the Agricultural Research Station, Fayetteville, Arkansas. The study was conducted to evaluate the response of soybean to different rates of imazosulfuron and halosulfuron. Both trials were planted in split-split-plot experimental design with four replications, where the main plot consisted of two herbicides- imazosulfuron and halosulfuron; the sub-plot consisted of eight herbicide rates: 1/256 \times , 1/128 \times , 1/64 \times , 1/32 \times , 1/16 \times , 1/8 \times , 1/4 \times , and untreated; and the sub-sub-plot consisted of two soybean cultivars- AG 4703 (conventional) and DK 4866 (STS). The labeled rates of imazosulfuron and halosulfuron were assumed to be 0.3 lb ai/A and 0.0468 lb ai/A, respectively. Visible injury (stunting and purple veins) to soybean was rated at weekly intervals throughout the growing season. End-of-season height of soybean was measured, and yield data were collected.

Impact

Imazosulfuron and halosulfuron did not cause significant injury to STS soybean, but conventional soybean was injured regardless of herbicide and application timing. However, conventional soybean plants recovered either partially or completely from the injury of both herbicides. Increasing rates of both herbicides resulted in greater height reduction of conventional soybean plants. Significant reduction in height of conventional soybean plants, as compared to the nontreated control, occurred at 1/16 \times and higher rates of imazosulfuron when applied at the VC growth stage; whereas, this significant difference occurred at 1/32 \times and higher rates of both herbicides when applied at the V6 growth stage. Increasing rates of both herbicides resulted in yield loss, meaning that growers will need to be mindful of the potential yield loss to soybean that can be caused by these herbicides applied to an adjacent rice crop.

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Funding

University of Arkansas Division of Agriculture; Arkansas Rice Promotion Board; Valent USA

Residual herbicide programs for control of glyphosate-resistant Palmer amaranth in cotton

Issue

Glyphosate-resistant Palmer amaranth is the biggest prob-

lem facing cotton producers in the mid-south. This problem has been made even worse by the widespread existence of acetolactate synthase (ALS)-resistant Palmer amaranth, leaving cotton producers no effective postemergence options for glyphosate/ALS-resistant Palmer amaranth in Roundup-Ready Flex cotton. Growers have shown interest in growing Widestrike cotton because of its tolerance to glufosinate (Ignite), high yield, and resistance to glyphosate. Use of glufosinate has helped in managing glyphosate-resistant Palmer amaranth, but glufosinate alone cannot be relied upon to manage this troublesome weed. Therefore, residual herbicides must be applied preemergence and also postemergence in combination with glyphosate or glufosinate. The key to managing glyphosate-resistant Palmer amaranth is to prevent the weed from germinating due to its rapid growth.

Action

An experiment was conducted in the summer of 2010 at the University of Arkansas in Fayetteville to evaluate early- and late-season control of glyphosate-resistant Palmer amaranth with residual herbicides in glufosinate (Ignite 280)- and glyphosate (Touchdown Total)-based programs. Residual herbicides included: fomesafen (Reflex), fluometuron (Cotoran), S-metolachlor (Dual II Magnum), prometryn (Caparol), and Smetolachlor + fomesafen (Prefix). Each treatment received either an application of Reflex at 14 to 21 days prior to planting cotton or Cotoran applied preemergence. Postemergence programs were Ignite 280 or Touchdown Total + Dual II Magnum applied at 2- to 4- leaf cotton, followed by Ignite or Touchdown Total + Prefix or Prefix + Caparol post-directed (12- to 13- leaf cotton).

Impact

Minimal crop injury was observed throughout the growing season. Glyphosate-resistant Palmer amaranth was controlled with glufosinate-based programs, regardless of which program was used (94-98%). Conversely, programs containing glyphosate controlled glyphosate-resistant Palmer amaranth only 37-70%. The key to managing glyphosate-resistant Palmer amaranth in a glyphosate-based program is to continually overlay residual herbicides to seedling establishment. After the glyphosate-resistant Palmer amaranth has emerged, there are no effective control options available in a glyphosate-based program.

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University of Arkansas Division of Agriculture; Syngenta

Methyl bromide alternatives for weed control in plasticulture bell pepper

Issue

For the past four decades, methyl bromide (MeBr) has been extensively used as a preplant soil fumigant for high value crops in plasticulture production systems. However in 1993,

MeBr was classified as a Class I- ozone depleting substance and mandated to be banned from further production beginning in 2005. With the loss of this compound, effective weed control has been a major challenge in commercial bell pepper production. Thus, effective and economically feasible methyl MeBr alternatives are imperative for weed control in plasticulture bell pepper production.

Action

In 2010, a field experiment was conducted to evaluate the effectiveness of allyl isothiocyanate (ITC) and metam sodium compared to MeBr for weed control in bell pepper grown under a low-density polyethylene (LDPE) mulch system. Experimental treatments consisted of allyl ITC at 450, 600, and 750 kg/ha; metam sodium at 180, 270, and 360 kg/ha; a standard treatment of methyl bromide plus chloropicrin (67% and 33%, respectively) at 390 kg/ha; and a non-treated check. Treatments were broadcastsprayed and incorporated into the top 0.1 m of the soil. Raised beds were prepared and covered with LDPE mulch. Three weeks after application of treatments, bell pepper

Impact

There was no crop injury observed for any of these treatments. Weed control was rate dependent for both chemicals and higher rates showed greater yellow nutsedge, large crabgrass, and Palmer amaranth control. Moreover, the highest rate of metam sodium and allyl ITC controlled weeds as effectively as MBr. At 8 weeks after treatment plan (WATP), yellow nutsedge was controlled 87% with allyl ITC at 750 kg/ha and 77% with metam sodium at 360 kg/ha. Large crabgrass control were 83% and 73% for metam sodium at 360 kg/ha and allyl ITC at 750 kg/ha, respectively. Control of Palmer amaranth was also effective with 81% and 78% from metam sodium at 360 kg/ha, and allyl ITC at 750 kg/ha, respectively. Total marketable fruit yield of 75.3, 68.4, and 62.8 t/ha were recorded for MBr, metam sodium at 360 kg/ha, and allyl ITC at 750 kg/ha, respectively. For total yield, the above three treatments did not differ significantly. Meanwhile, yield in the nontreated check was recorded 18.1 t/ha. Viable yellow nutsedge tubers per m² were 54 for MBr, 377 for allyl ITC at 750 kg/ha, 1066 for metam sodium at 360 kg/ha, and 3466 for the check. This experiment shows that allyl ITC at 750 kg/ha and metam sodium at 360 kg/ha have potential for controlling weeds and providing yield similar to the MeBr for plasticulture bell pepper production.

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University of Arkansas Division of Agriculture; USDA

Herbicide programs for control of resistant barnyardgrass

Issue

Barnyardgrass is the most problematic weed in Arkansas rice production, causing yield reduction, lodging, and poor grain quality. It infests most of the Arkansas rice acreage and has biotypes resistant to Stam (propanil), Facet (quinclorac), Command (clomazone), and the acetolactate synthase (ALS)-inhibiting herbicides. Growers tend to use the same herbicide programs year after year, placing tremendous selection on barnyardgrass for the evolution of resistant biotypes. Although resistance management programs are now in effect to deter evolution of new resistant biotypes, effective herbicide programs are needed to control existing resistant biotypes.

Action

A field study was conducted at Lonoke, Ark., on a Calhoun silt loam to develop herbicide programs for effective control of Stam-, Facet-, Command-, and ALS-resistant biotypes. Susceptible and resistant biotypes to Stam, Facet, Command, and ALS herbicides were planted perpendicular to rows of drill-seeded rice, and herbicides were applied at different timing to determine the best combinations for control of the resistant biotypes. Herbicide treatments included combinations of Command, Prowl H20, Ricebeaux, Facet, Ricestar HT, Stam, Regiment, Grasp, and Bolero applied preemergence (PRE) followed by delayed preemergence (DPRE) or DPRE followed by early postemergence (EPOST) followed by preflower (PRE-FLD).

Impact

Treatments consisting of Command + Facet PRE controlled all resistant biotypes early in the growing season better than did DPRE applications of Command, Facet, or Bolero + Prowl H20. With the addition of Ricebeaux + Ricestar HT, Regiment, or Grasp PREFLD, season-long control of all resistant biotypes was obtained. Treatments with DPRE fb EPOST fb PREFLD applications controlled all resistant biotypes 100%; however, herbicide applications at three different timings using multiple herbicides was less economical than a PRE application followed by a PREFLD application. Alternative herbicide programs were effective in controlling the resistant barnyardgrass biotypes, and these herbicide programs can be integrated into current Arkansas rice culture, serving as a means of controlling currently resistant biotypes and reducing the risks of additional population to further evolve resistance.

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Funding

University of Arkansas Division of Agriculture; Arkansas Rice Promotion Board

Mechanism of glyphosate resistance in a johnsongrass (*Sorghum halepense*) biotype from Arkansas

Issue

Johnsongrass is one of the most troublesome weeds of the world and is listed as a noxious weed in Arkansas. Reduced johnsongrass control with the recommended application rate of glyphosate was reported in a continuous soybean field near West Memphis, Ark., in the fall of 2007. The mechanism of glyphosate resistance in johnsongrass is unknown.

Action

A study was conducted to determine if reduced absorption and/or translocation are the mechanisms of glyphosate resistance. The second fully expanded leaf of individual johnsongrass plants at five- to six-leaf stage was treated with 4- μ l of radioactive herbicide solution (nonradioactive glyphosate at 870 g ae/ha plus 1.48 kBq of 14 C-glyphosate) on the adaxial side.

Glyphosate absorption was similar in resistant and susceptible biotypes at 72 hours after treatment (HAT). However, the treated leaf of the resistant biotype retained 28 percentage points more absorbed 14 C-glyphosate compared to the susceptible biotype at 72 HAT. Additionally, the resistant biotype had less 14 C-glyphosate translocated to the aboveground tissue below the treated leaf and to roots compared to the susceptible biotype at 24 and 72 HAT.

Impact

Reduced translocation and increased retention of glyphosate in treated leaves is the probable mechanism of resistance in glyphosate-resistant johnsongrass. Additional modes of action will be needed with glyphosate to obtain acceptable control of the resistant biotype.

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University of Arkansas Division of Agriculture; Arkansas Soybean Promotion Board

Ignite weed control programs in soybean

Issue

Glufosinate (Ignite 280) controls many annual weeds, but dependence on glufosinate alone for season-long weed control may have limitations.

Action

A study was conducted in 2009 to evaluate broadleaf and grass weed control in a Liberty Link herbicide program. The objective was to determine the differences in efficacy of various preemergence (PRE) herbicides used prior to postemergence (POST) application of Ignite 280 in a Liberty Link soybean program. Treatments evaluated were PRE herbicides: Valor, Valor + Sencor, Valor XLT, Authority First, Authority MTZ,

Prefix, and Dual Magnum. All PRE applications were then followed by (fb) Ignite 280 at 0.4 or 0.65 lb ai/A at 22 days after emergence (DAE) or 0.4 lb/A at 22 fb 44 DAE.

At 3 weeks after emergence (WAE), only Dual Magnum failed to control all broadleaf weeds at least 90%. Prefix and Authority MTZ controlled pitted morningglory and hemp sesbania at less than 90%. Dual Magnum and Prefix were the only PRE treatments that controlled at least 90% of the barnyardgrass. Valor XLT, Authority First, Prefix, and Dual Magnum provided weed control of broadleaf signalgrass greater than 90%. At 10 WAE, Valor fb Ignite at 0.4 and 0.65 lb/A, and Valor XLT fb Ignite at 0.4 lb/A had significantly less barnyardgrass control (77, 85, and 62%, respectively) than the other treatments. Single applications of Ignite (0.4 lb/A) at 22 DAE only provided season-long control of pitted morningglory, while at 0.65 lb/A, prickly sida and hemp sesbania were controlled season-long. However, a split application of 0.4 lb/A at 22 fb 44 DAE was effective for all species (greater than 90%).

Impact

Ignite in combination with a PRE herbicide can be an effective treatment for season-long weed control in Liberty Link soybean.

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Funding

Soybean Promotion Board; Bayer CropScience; University of Arkansas Division of Agriculture

Effect of Roundup-Ready technology on weed population dynamics in soybean

Issue

The objective of this research is to help reduce weed emergence in producer fields.

Action

Field studies were conducted from 2007 through 2009 at the University of Arkansas Division of Agriculture Pine Tree Research Station, to evaluate the effects of late-season glyphosate applications on the density and seed production (SP) of common weeds in a Roundup Ready soybean production system. The experiment was designed as a randomized complete block with eight treatments and four replications. Treatments were: 1) Roundup WeatherMax (RWM) applied at V3 stage of soybean; 2) RWM applied at V3 followed by (fb) RWM at weed flowering (WF) stage; 3) RWM applied at V3 fb RWM at WF fb RWM at 10 days sequential (DSeq) after WF stage; 4) RWM applied at V3 fb RWM at WF fb RWM at 30 DSeq; 5) RWM applied at V3 fb at V6; 6) RWM applied at V3 fb V6 fb WF; 7) RWM applied at V3 fb V6 fb WF fb 10 DSeq; and 8) RWM applied at V3 fb V6 fb WF fb 30 DSeq. Roundup WeatherMax rates were 0.84 kg ae/ha (1×) at V3 and V6 stages of soybean growth and 0.42 kg/ha (1/2×) at weed flowering (except treatment 2) and sequential applications. Each year WF application was triggered by barnyardgrass (2007) or

Palmer amaranth (2008 and 2009).

Roundup WeatherMax applied only once at the V3 stage of soybean provided only 30%, 39% and 17% (averaged over years) of pitted morningglory, prickly sida, and barnyardgrass, respectively, and resulted in significantly lower soybean yield than other treatments. Treatments 2, 5, and 6 (with no sequential application) did not provide 100% control of all weed species present. Therefore, weed seed was produced in these plots. Only those treatments (3, 4, 7, or 8) with the sequential applications provided 90% to 100% control (averaged over years) of all weed species with no weed seed production and reduced weed soil seedbank. At the end of the study, the weed density decreased from 366 to 25 plants/m² which resulted in almost complete lack of weed emergence after 3 years.

Impact

To reduce weed seed density (reduce soil seedbank) or to stop weed seed production, three applications of RWM (0.84 kg/ha) at V3 fb RWM (0.42 kg/ha) at WF fb RWM (0.42 kg/ha) at 10 to 30 DSeq are required.

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Funding

Soybean Promotion Board; University of Arkansas Division of Agriculture

Global warming and high temperature stress in cotton

Issue

Global warming has focused attention on the need for improved understanding of crop responses to heat stress. There is a negative correlation between high temperature and yield in cotton. This is particularly prevalent during the flowering early boll development resulting in lowered yields and unpredictable year-to-year yield variability.

Action

Field and controlled environment studies have quantified the effect of high temperature on growth and yield development. The thresholds for heat stress on physiological parameters were established and the mode of action of the stress determined. Heat stress affects the carbohydrate supply from the leaf to the flower, and also lowers the energy status in the flower, which decreases pollen tube growth and decreases seed fertilization. The cotton plant has an antioxidant enzyme system which helps to ameliorate the heat stress, but this is limited in current commercial cultivars.

Impact

This research on high temperature stress in cotton has explained the yield variability experienced by Arkansas farmers by biochemical changes occurring in the flowers that decreases the number of developing seeds in the ovary. This has allowed us to: (a) predict from weather data when heat stress will affect reproductive growth and subsequent yields, and (b) formulate and start testing methods of amelioration of the heat stress as

well as on collaborative work with the plant breeder to select for thermotolerance.

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Funding

Cotton Incorporated; University of Arkansas Division of Agriculture

Improving high temperature tolerance in cotton

Issue

Cotton originates in hot climates but does not necessarily yield best at high temperatures. There is a negative correlation between high temperature and yield in cotton. The ideal temperature range for cotton is reported to be from 68 °F to 86 °F. However, average daily maximum temperatures during early boll development in Arkansas are almost always above 95 °F, well above the optimum for photosynthesis and reproductive development. This is considered a major reason for lowered and variable yields experienced in cotton production. Current commercial varieties in cotton are susceptible to heat stress resulting in lowered yields and poorer fiber quality. There is an urgent need to determine methods of selecting for thermotolerance and screen available germplasm for thermotolerance.

Action

Growth room and field studies have evaluated techniques for quantifying high temperature response and the ability to tolerate these extremes. Our earlier research established the temperature thresholds for successful photosynthesis and reproductive development. In this study we evaluated various physiological and biochemical methods to accurately and reliably detect plant response to high temperature. We selected two measurements: chlorophyll fluorescence and membrane leakage as the best indicators of plant response to high temperature stress. We also developed and tested techniques of how to determine heat tolerance, by imposing heat stress, measuring plant response, and then removing the temperature stress to determine the plants ability to recover. This information was used to screen lines from the Arkansas breeding material as well as wildtypes for temperature tolerance.

Impact

This research has provided the cotton plant Breeder with information for screening and selecting for temperature tolerance. This study is ongoing. This research also discovered the physiological mechanisms of how thermotolerant cultivars, from hot countries such as Pakistan where cotton is regularly grown at temperatures above 100 °F, tolerate heat.

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Cotton Incorporated; University of Arkansas
Division of Agriculture

Amelioration of stress in the cotton crop

Issue

The cotton crop suffers from heat and drought stress, which results in lost yield and lower fiber quality. The ideal temperature range for cotton is from 68 °F to 86 °F, whereas the average daily maximum temperatures during mid-season in Arkansas are always above this optimum. Also, even though a large percentage of the cotton acres are irrigated, they still suffer from water shortages during hot days, resulting in lost yield. This has led to a need to determine methods of ameliorating crop stress in order to achieve yield potentials. One such method is by the use of plant growth regulators (PGRs).

Action

We have evaluated the available PGRs for many years, but with recent insight into the mechanisms of plant response to stress, we have been able to focus on PGRs that would have a beneficial effect under stress conditions. One such PGR is 1-Methylcyclopropene, which blocks the attachment of the stress hormone ethylene and by so doing delays stress or prevents mild stress effects under high temperature or water stress. We have tested this PGR in field and growth room studies for several years, and determined its mechanism and how best to use it.

Impact

Use of 1-MCP to field grown cotton has shown a decrease in the effects of stress (manifested in increased antioxidant enzyme activity and decreased chlorophyll fluorescence) and a benefit in yield. The Plant Growth Regulator program continues to supply a service to Arkansas by evaluating available PGRs and making the results available to farmers and extension.

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AgroFresh Inc., Syngenta; University of Arkansas
Division of Agriculture

Corn leaf greenness and the association with leaf nitrogen and grain yield

Issue

Nitrogen fertilization is important for corn yield, but applying too much N is expensive and has environmental consequences. Current methods of determining how much N to apply during the season require specialized equipment or have long turnaround times that limit their utility.

Action

We developed a method of determining N status of corn leaves by measuring “greenness” of leaves from digital images.

Data from two years at multiple locations show that “greenness” is closely associated with leaf N concentration and that “greenness” from digital images taken at tasseling is closely associated with corn grain yield.

Impact

The only equipment necessary for measuring “greenness” of corn leaves is a digital camera. Digital images could be sent to a website or researcher for quick and inexpensive evaluation of leaf N status. Continuing research is focused on calibrating “greenness” values from young corn plants to determine appropriate amounts of N fertilizer to apply.

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Funding

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

Foliar fertilization of putting green turf

Issue

Surveys conducted by our research program indicate that golf course superintendents apply a high percentage of the total fertilization to their putting green turf as a foliar application, which is defined as nutrient absorption through the leaf tissue. Unfortunately, there have been no studies that have investigated the efficiency and efficacy of foliar uptake of nutrients in putting green turf, especially under field conditions. In addition, there have been no studies that have investigated potential loss mechanisms when applying nutrients in a foliar approach.

Action

We have conducted a range of research projects that have investigated the uptake efficiency and ammonia volatilization losses of foliar-applied nitrogen to both creeping bentgrass and hybrid bermudagrass, the major turfgrass species used on putting greens in Arkansas. These studies have utilized isotopic nitrogen sources that can accurately trace both uptake efficiency and environmental loss.

Impact

The results of these studies are the first to describe the uptake kinetics of foliar-applied nitrogen to golf course putting greens. These results have provided turfgrass managers with necessary information to integrate other cultural practices with a foliar nutrient application for both maximum efficiency and minimal environmental losses. These studies have demonstrated that foliar applications of nitrogen experience minimal environmental loss, suggesting that these approaches have great potential to minimize the environmental impact of nitro-

gen applications in a range of turfgrass situations. Finally, these studies have clearly shown that basic nitrogen sources such as urea or ammonia are absorbed as readily as more expensive nitrogen sources, which can greatly reduce fertilizer costs to golf course managers.

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University of Arkansas Division of Agriculture; OJ Noer Research Foundation; United States Golf Association

Reproduction of reniform nematode (*Rotylenchulus reniformis*) on contemporary soybean varieties and breeding lines

Issue

Upland cotton has no commercial varieties identified with resistance to the reniform nematode. Recently, aldicarb, the primary nematicide used in field control of this very economically damaging nematode pest was suspended from use by the U.S. Environmental Protection Agency. The only remaining nematicide requires specialized application equipment and must be done some time pre-planting and is too often not effective in its control. The rotation of non-host crops such as resistant soybean, corn and sorghum are the main control choice left for the producer. Most commercial soybean varieties are susceptible to the reniform nematode and thus not effective as a rotation choice. Identification of resistant lines is imperative for establishment of an effective cotton-soybean rotation.

Action

All new commercial varieties to the Arkansas Soybean Variety Trials are tested annually for their ability to have reniform nematode reproduce on them. Those with low level of reproduction are termed resistant. Those soybean varieties identified as resistant are useful as an economically attractive rotational crop in infested cotton acreage. In Arkansas about one third of all cotton acreage is infested by the reniform nematode and resistant soybean is a very attractive rotation crop for the nematodes control. One year in resistant soybean is usually sufficient to control reniform on cotton the following year. We also test southern public soybean breeding lines for resistance.

Impact

Until reniform nematode resistance is available in acceptable commercial cotton varieties, a cotton-soybean rotation is the remaining most economically feasible method of reniform control. Uncontrolled in cotton, the reniform nematode can reduce yield to the point where cotton production is no longer profitable. A good rotation, such as corn-cotton, sorghum-

cotton or reniform resistant soybean-cotton can restore profitability to these infested fields. Rotation has an environmental advantage over chemical nematicides in that it has no long lasting effect on the crop and is safe to use. There are no detrimental human health concerns with using rotations.

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Arkansas Soybean 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 seven 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. The N-ST*R was validated at 12 silt loam sites in 2010 that varied in native soil nitrogen availability, and it predicted the correct nitrogen fertilizer rate to achieve 90%, 95% and 100% relative grain yield at all 12 sites. Validation studies will continue in 2011 with more focus placed on the implementation of field-scale strip trials for research and demonstration. The states of Louisiana, Mississippi, and Texas have continued to collaborate with us on the development of N-ST*R for silt loam soils and validation should begin shortly. 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 where rice is grown in Arkansas and the southern Ricebelt.

Impact

The new Nitrogen-Soil Test for Rice will allow site-specific nitrogen fertilizer rate recommendations for rice because it will enable 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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Funding

Arkansas Rice Research and Promotion Board; USA Rice
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Effect of ground cover management and nutrient source on sustainable production of an organic apple orchard

Issue

Consumer demand for organic apples is increasing significantly, and the price premiums paid to organic apple growers has been substantial. Additionally, both consumers and farmers are seeking sustainably produced fruit. There is very limited research on sustainable organic production systems in the southern region of the U.S. and within its warm humid environment.

Recent surveys of organic fruit growers in the U.S. and fruit growers in the southern region identified two primary issues facing production, control of weeds and under-tree vegetation (ground cover), and how to apply nutrients in the organic system. There is the potential for significant interactions among various methods of managing ground covers and the application of nutrients from various sources. Very little work worldwide has been done in warm humid environments testing the interactive effects of ground cover management and nutrient source in organic systems. Likewise, there is very limited study on the economics of organic production systems in these environments and the impacts that treatments and management may have on soil health.

Action

A study was established to test the interaction of four types of ground cover management as follows: 1) urban green compost, 2) fresh wood chips, 3) shredded institutional paper, 4) mow-and-blow where vegetation is grown under and between

trees and frequently mowed and blown under the trees as a mulch. Overlaying those treatments, nutrient source treatments were applied as follows: A) a control, where the ground cover management treatment becomes the source of nutrition; B) a composted poultry litter; and C) a certified organic commercial poultry based fertilizer. Trees of 'Enterprise'/M26 were planted in moderate densities of 6 feet between trees and 12 feet between rows, and trained to a tall slender pyramid using the vertical axis training principles. The year 2010 was the first year of production in the orchard.

Impact

Both ground cover and nutrient source have profound effects on tree growth during the establishment of an orchard. There was no significant difference in tree height and all trees had achieved target height of at least 10 feet. Although yields in 2010 were poor due to weather conditions during the post-bloom and summer periods, trees with wood chip mulch had the greatest yields, more than twice that of shredded paper. Trees treated with poultry litter had more weeds than those without additional nutrients added. Nutrient source treatment did not affect tree size. However, trees without supplemental nutrition averaged 10% less total yield.

These data provide the basis for building recommendations for organic orchard management in Arkansas. Data are used to provide economic models for organic production and decision support systems. The management of insect pests in the organic system provides empirical and practical information to growers on pest management. The impacts of management on soil health and quality are being measured and will contribute to evaluation of environmental sustainability and impact of the production system. In total, this trial has provided evidence for the potential for organic apple production in Arkansas.

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USDA – Organic Agriculture Research and Extension Initiative Program; University of Arkansas Division of Agriculture

Sustainable production and season extension of berries with high tunnels

Issue

Blackberry production is typically a short season crop in Arkansas with a range of cultivars providing yields over a five to six week period beginning in mid-June. Typically the environment in Arkansas is too hot for the production of red raspberries. New cultivars of fall-bearing primocane blackberries developed at the University of Arkansas have some

limitations to production due to extremely hot temperatures during August and the fact that the fruit season ends quickly with frosts in October. However, the use of high tunnels, minimally structured and heated film covered “greenhouse-like” structures may have the opportunity of allowing for earlier growth and cropping of blackberries in the spring and the production of spring raspberries during periods of cooler weather. Likewise, high tunnels may be used for the production of fall-bearing primocane blackberry and raspberries if bloom is delayed through horticultural techniques until cooler temperatures prevail, and fruit can be protected during frost occurrences in late October and early November. High tunnels have the possibility of extending a five to six week crop with an additional four to six weeks in the spring with traditional florican blackberries and raspberries, and an additional six to eight weeks in the fall with primocane types.

Action

An interdisciplinary research trial was established to produce florican blackberries and raspberries in high tunnels to advance spring production, and primocane blackberries and raspberries for fall production. A third trial of primocane cultivars that have the potential for double cropping in the high tunnels, both late fall and early spring production, was established.

The trials demonstrated that blackberries and raspberries can be grown in high tunnels. With no additional heat input, tunnels closed in mid February allowed for an advanced harvest season of two to three weeks. This may be further advanced with the addition of heat during cold periods. It was found that high tunnels may provide minimal frost protection (just a few degrees), but with minimal additional heat inputs, the early crop can survive mild frosts (≥ 25 °F) while fruit in the field are damaged and do not survive. Pruning has some impact on delay of flowering in primocane types and offers growers means of controlling period of harvest. High tunnels covering primocane fruiting berries with minimal heat during fall frost events may allow for harvest to continue into November. Generally, blackberries and raspberries, both florican and primocane types, grown in high tunnels produce more total fruit and larger fruit than plots in the field.

Impact

The high tunnel production system, in combination with traditional field production allows for significant extension of the production season and especially sale of fruit “off-season” when market prices are high. High tunnels also protected fruit from damage caused by rain and hail. These increases in production and quality, and loss of crop due to environmental circumstances give economic benefits to growers.

Economic analyses indicate that with price premiums received for out-of-season production, and with the increased harvested and marketable yields from high tunnels, the investment in tunnels is worthwhile. However, it is felt that because the berry crops only need the tunnels for a period of February to April for spring production and October to December for autumnal production, it may be worthwhile to consider movable tunnels so that other crops can be grown in the tunnels in the seasons opposite of the period required for the berries.

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Funding

USDA Integrated Organic Program; Organic Farm Research Foundation; Southeastern Small Fruit Research Consortium; University of Arkansas Division of Agriculture

Evaluation of LibertyLink soybean varieties**Issue**

An estimated 350,000 acres of soybean were infested with glyphosate-resistant Palmer amaranth (pigweed) in Arkansas in 2010. This problem cost growers an estimated 42 million dollars in the form of added weed control cost and lost yield. The only weed-control system similar to RoundUp-Ready is the LibertyLink®/Ignite® herbicide system. Since LibertyLink soybean varieties have only been commercially available since 2009, little is known about how these varieties will perform in Arkansas.

Action

In 2009 and 2010, a RoundUp/LibertyLink systems comparison study was conducted at two different locations. Three LibertyLink and four RoundUp-Ready soybean varieties were evaluated in this study. Soybean varieties ranged in maturity groups from 4.8 to 5.1. Each location was sprayed with Prefix herbicide preplant, and two applications of RoundUp or Ignite herbicides during the growing season depending upon the soybean variety. Yield and other agronomic characteristics were evaluated for each soybean variety.

Impact

Results from this research have shown that currently available LibertyLink soybean varieties have yields very comparable to some of the highest yielding and popular RoundUp-Ready soybean varieties. It appears that these LibertyLink soybean varieties do not have the “yield drag” that the original RoundUp Ready soybean varieties had when initially released. With the increase in soybean acreage infested with glyphosate-resistant Palmer amaranth, as much as 875,000 acres in Arkansas can be planted with LibertyLink soybean varieties. Use of the LibertyLink/Ignite system could save soybean producers 105 million dollars in lost yield due to glyphosate-resistant Palmer amaranth.

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Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture; Bayer CropScience; Pioneer Hi-Bred; Delta Grow; Progeny AG

Use of brassica cover crops or amendments in strawberry production systems to increase microbial diversity**Issue**

Soilborne pathogens are a limiting factor for strawberry production and historically have been managed through the use of fumigants, especially methyl bromide. Research has suggested that brassica amendments may be used to suppress soilborne pathogens of a number of crops, including strawberry, reducing the need for soil fumigation. *Brassica* spp. produce glucosinolates which decompose into chemicals that are inhibitory to a range of microorganisms including nematodes, fungi and bacteria suggesting antimicrobial compounds are responsible for disease suppression. Other research suggests the benefits of using brassica cover crops could be associated with enriching the microbial population resulting in suppression of pathogens. Development of a sustainable production system for strawberry will require that alternative strategies such as brassica amendments be developed to replace chemical soil fumigants.

Action

The objectives of this project included characterizing plant pathogen and general microbial population changes in soils under different sustainable management practices for strawberry production systems at two different locations in Arkansas. A brassica cover crop, mustard seed meal, solarization or a combination of the cover crop and solarization were compared to no soil treatment prior to establishing the strawberry crop. The goal of this research effort was to contribute to the development of a sustainable production system by suppression of soilborne strawberry pathogens without the use of chemical soil fumigants. General microbial and suspect pathogen populations from soils were quantified by plate count methods. Additional soil samples were taken after cover crop incorporation to generate denatured gradient gel electrophoresis (DGGE) profiles for bacterial and fungal populations. Soil treatments tended to increase bacterial, fungal and actinomycete populations in the soil at the time of brassica cover crop termination and at strawberry transplant for the brassica cover crop, brassica plus solarization and mustard seed meal amended soils compared to solarized only and control soils. Total culturable, bacterial populations were significantly higher in soils that had been planted with a brassica cover crop followed by solarization and soils receiving mustard seed meal amendments at both locations at the time of strawberry transplanting. The DGGE produced unique profiles of bacteria and fungi compared to that of control soils for soil samples taken after the brassica cover crop was incorporated into the soil. At the time of strawberry transplant, all bacterial DGGE profiles of soils

from both locations receiving different treatments were still distinct and grouped separately in dendograms; fungal DGGE profiles were not as consistently distinct among treatments.

Impact

This project has successfully demonstrated how including soil treatments such as brassica cover crops or mustard seed meal applications as a practice in annual strawberry production can enhance the soil microflora, especially the bacterial community. Since changes could be observed in both the bacterial and fungal communities throughout the sampling times, this system has the potential to produce a soil that is more diverse and possibly suppressive to soilborne pathogen populations or colonization of roots. The impacts of these shifts in the soil microflora for soilborne diseases should be compared to chemical fumigants in soils with a history of strawberry production to examine their value in developing a sustainable strawberry production system.

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Southern Region Sustainable Agriculture Research and Education (SARE); 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 with which cultivar 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

This year only a few field tests resulted in significant stand or yield improvements and when those occurred it was with the broad spectrum seed treatments not metalaxyl (specific for *Pythium* spp.). Growth chamber tests with field soil resulted in significant seed treatment effects at low, moderate and high temperatures indicating the importance of soil moisture in seedling disease. Unlike the previous year, only the broad spectrum seed treatments were effective while metalaxyl was rarely effective. This indicates that *Pythium* spp. alone were not the primary pathogens responsible for stand reductions. There were differences between soils with more seedling disease occurring at high temperatures in Stuttgart soil than in Hope soil. The amount of seedling diseases resulting from co-inoculations with different seedling pathogens depended on the specific isolates with some combinations even reducing disease. The quality of seed stored in warehouses began to decline in July and this resulted in reduced stands.

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 of Arkansas planting conditions. Our isolation work is identifying the key components of the seedling disease complex and how these components interact. This will help us direct future research.

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Funding

Arkansas Soybean Promotion 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 Southern U.S. In 1998, an aflatoxin outbreak cost Arkansas growers an estimated \$15,000,000 and made a significant portion of the crop unmarketable. Growers have focused on intensive irrigation and other crop management methods to minimize the problem, but each year we have localized outbreaks that reduce profits and create marketing problems by increasing fear and wariness among grain buyers in the region. An effective control for aflatoxins 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

The objectives of this study were to express an α -amylase inhibitor (AI) 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. The 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 T0 lines with the B01 α -amylase inhibitor transgene have been regenerated and are being grown to maturity in the greenhouse. This large number of lines will allow us to select those that have high levels of the α -amylase inhibitor, but that do not show any negative effects of transformation. The AI RNA expression levels in these lines have been estimated using Q RT-PCR. An antibody to the AI protein has been made and tested. Protein expression levels from the leaves of T1 plants have been analyzed and lines with higher expression of AI have been identified.

Impact

These transgenic lines represent the first attempt to develop *A. flavus* and aflatoxin resistance using a transgenic approach in the U.S. A transgenic approach has several advantages over conventional breeding. Incorporating this transgene into elite breeding lines is much easier than selecting for the polygenic resistance to *A. flavus*. Also, this α -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. These efforts have developed the first transgenic corn lines in the world with the potential to control aflatoxins.

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

Molecular diagnostics for pathogenic nematodes 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

Both conventional and real-time polymerase chain reaction (PCR) methods have been developed for *Rotylenchulus reniformis* (reniform nematode). The conventional method has been successfully combined with two other PCR detection methods for root-knot and soybean cyst. The primer concentrations and other PCR conditions for detection of these individual nematodes in the multiplex assay have been optimized. Numerous races of soybean cyst nematode have been obtained and successfully detected with the multiplex assay. Reniform,

soybean cyst, root-knot nematode have been successfully detected individually with the multiplex assay.

Impact

For the first time, molecular diagnostic methods have been developed for reniform nematode, an economically important pest on numerous crops in the Southern U.S. In addition, the real-time PCR method represents the first unbiased method for estimating reniform nematode numbers on plant roots. This real-time PCR quantification will be a benefit to plant breeders, plant pathologists and other researchers. The conventional PCR assay will be used directly in a multiplex diagnostic assay for the three most important nematodes in soybean and the two most important in cotton. This multiplex assay will improve 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 purchases, 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 approximately 40% of samples that do not have any significant numbers of nematodes in them.

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Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture

Impact of resistant pigweed control program efforts in Arkansas soybean production

Issue

Because of the continued reliance on Roundup-Ready technology in soybean, resistance to the herbicide Roundup has developed in a potentially very troublesome weed, Palmer amaranth or "Pigweed". This weed can cause devastating yield losses in soybean if not controlled.

Action

Multiple studies were conducted in 2010 to evaluate control measures for this pest. Locations were established on resistant sites in Jackson, St. Francis and Lee counties. Recommendations were developed and implemented in 2010. Field days and grower meetings were used to focus on this pest.

Impact

Over 1000 people attended field days at Widener and Newport Arkansas to look at plots evaluating pigweed control in soybean. In addition, a meeting was held in November to highlight pigweed control efforts. The "Pigposium" was a great success, with over 600 registered.

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Funding

Arkansas Soybean Promotion Board; University of Arkansas Division of Agriculture; various industry support

An approach for single-pass rice drying

Issue

Rice is typically harvested at moisture contents (MCs) greater than those safe for storage. Thus, it is dried immediately after harvest to ~12% (w.b.). With increased harvesting and trucking capacity, the rate at which rice is delivered to driers has increased dramatically, placing great pressure on driers. The current approach used by commercial driers is to dry rice in passes, exposing the rice to elevated temperatures to produce rapid drying rates and reducing MC by two to three percentage points per pass, then tempering the rice for several hours, then repeating the pass. This approach can take a long time to complete, but is conventionally thought necessary to maintain milling quality. Improper drying or tempering produces fissures in the kernel endosperm, leading to broken rice during subsequent milling and end-use processing operations. Broken kernels drastically reduce milling quality, which is quantified primarily by the mass percentage of rough rice that remains as head rice (milled kernels three quarters or more of the original kernel length) after complete milling. This mass percentage directly determines economic value of a rice lot. One of the foremost goals of the University of Arkansas Rice Processing Program is to increase the drying throughput rate without incurring milling quality reduction.

Action

Our previous research has produced a hypothesis, referred to as the “glass transition hypothesis,” which explains the cause of fissure formation in rice kernels during the drying process. The hypothesis states that if kernels are heated above their glass transition temperature (T_g), they will transition from a “glassy” to a “rubbery” state. In the rubbery state, diffusion of moisture occurs at a great rate, causing drying and tempering to proceed much more rapidly than in the glassy state. However, as drying proceeds in the rubbery state, intrakernel MC gradients develop and under current, typical drying air conditions, the kernel periphery will transition back to the glassy state. If too great a volume of the kernel periphery transitions into the glassy region while the rubbery center core remains in the rubbery region, the tremendous differences in properties between states will produce kernel stresses that cause fissuring.

Based on the T_g hypothesis, an approach has been formulated in which air conditions would be controlled such that the kernel periphery is maintained in the rubbery state throughout drying, just as would the kernel core. This approach is postulated to prevent intrakernel state differences and kernel fissuring. Our laboratory experiments have shown that this approach can be used to dry rice from field MC to 12.5% MC in a single pass, without milling quality reduction, as long as

tempering is performed before cooling. These experiments support the technical possibility of single-pass drying. Current work is evaluating this approach in terms of color and functional changes that might occur.

Impact

This work could lead to implementation of drying strategies that increase the drying rate of rice and other grain driers, without causing physical quality degradation.

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Funding

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

Urease inhibitor effects on urea fertilizer applied to winter wheat

Issue

Urea is the most common nitrogen (N) source used for fertilization of row crops in Arkansas. A large proportion of the urea that is applied to summer-grown crops is commonly amended with Agrotain®, a urease inhibitor. Research has shown that this product consistently reduces N loss via ammonia volatilization from surface applied urea when environmental (weather and field conditions plus crop management) conditions are conducive. Growers have questioned whether a urease inhibitor would be of benefit for urea applied to winter wheat in February and March, when weather related factors are less conducive for ammonia loss.

Action

Research was established in six different fields during a 3-year period with N applied at four different times between mid February and early April. Urea and Agrotain-treated urea were applied at a suboptimal rate of 75 lb N/acre and at a near-optimal rate of 125 lb N/acre. The suboptimal N rate was used to evaluate whether wheat yield benefited from the urease inhibitor, and the near optimal N rate examined how N application time influenced wheat yield.

Impact

Research results, averaged across 24 N applications, showed a 3% yield benefit from urea amended with the urease inhibitor compared to urea alone. Wheat yield response to the urease inhibitor across 24 N applications was further characterized to understand the magnitude and frequency of the benefit. Results indicated that the urease inhibitor, compared to urea only, provided no significant yield change 58% of the time, but yields were increased by, on average, 4, 6, and 13 bu/acre for 21%, 13%, and 8% of the N applications, respectively. These results indicate that ammonia loss can be significant and lead to reduced yield in some wheat fields. Additional research is needed to understand the factors controlling these losses and provide more specific recommendations to wheat growers.

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Funding

University of Arkansas Division of Agriculture

Quantifying the accuracy of soil-test phosphorus for soybean production

Issue

Soil tests are not infallible, but they represent the best available science for making sound soil nutrient and crop fertilizer management decisions. Proper interpretation of soil-nutrient availability index values requires that the availability index be reasonably well correlated with crop growth/yield response to the addition of that nutrient. Previous Arkansas research has shown that the Mehlich-3 soil test is an excellent indicator of soil K availability, but the accuracy and interpretation of phosphorus (P) extracted by this method have not been properly assessed for soybean.

Action

Forty site-years of research were established from 2004 to 2010 to evaluate soybean response to P fertilization. Each trial evaluated soybean yield response to two to five different P rates compared to soybean receiving no P. Mehlich-3 extractable soil P (0-4 inch depth) was measured at each site.

Impact

The Mehlich-3 P availability index was significantly correlated with the relative yield of soybean receiving no P fertilizer. Mehlich-3 P explained 32% of the soybean yield variation among site-years and was highly (90% of the time) accurate at predicting that soil with >20 ppm P required little or no P fertilizer to increase yield. For soils testing 11-20 and <11 ppm, positive (6-12% increases) yield responses to P fertilization occurred 25% and 63% of the time, respectively. Based on these findings, P fertilizer recommendations for soybean were revised for the 2011 cropping season. The rates of P recommended for soils having Very Low to Medium P levels were reduced. Additional research is being conducted in an effort to improve the accuracy of P fertilizer recommendations on soils having low P availability index values by the addition of more site-years, examining other soil test methods, and use of other soil chemical properties in addition to P.

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

Presence of unneeded DNA elements in transgene locus

Issue

An ideal transgenic plant is expected to contain a precise transgene locus without a selection marker gene. However, for the identification and recovery of transgenic plants, it is necessary to co-introduce selection marker genes.

Action

A precise transgene locus can be efficiently developed by the 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 2010, we demonstrated that FLPe is not only efficient in excising marker genes out of the transgene locus; it also efficiently integrates foreign DNA into previously inserted target sites in the rice genome.

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Funding

University of Arkansas Division of Agriculture; Arkansas Bioscience Institute; USDA-NIFA; NSF

Molecular mechanisms of gene suppression effects on plant response to environment, disease and defense

Issue

Genetic variability is an extremely important resource for developing new crop varieties. Recently, scientists have learned that 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. In 2010 we characterized a suppressor mutation that can release transcriptional silencing of hypermethylated phyA gene without changing its methylation level. However, in the pres-

ence of this suppressor mutation, the phyA³ epiallele undergoes site-specific demethylation. Thus, while a percentage of DNA methylation does not change, a particular CG site loses its methylation, which underlies phenotypic reversion.

Impact

Understanding 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 construct (a gene construct lacking transcription terminator) for robust gene silencing in plants using *Arabidopsis* as the model. In 2010, we showed that this terminator-less construct is also effective in rice. We targeted the rice phytoene desaturase gene and found that up to 80% reduction in gene activity is obtained upon introduction of the terminator-less construct.

Impact

The simpler construct will serve as a useful biotechnology tool.

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University of Arkansas Division of Agriculture; Arkansas Bioscience Institute; USDA-NIFA; NSF

Japanese beetle biology and control in Arkansas

Issue

The Japanese beetle, a serious, exotic pest that entered Arkansas about 1997, has steadily spread throughout the state, causing problems in horticultural crops and turf. Both larvae and adults feed on hundreds of horticultural plants, causing economic and aesthetic damage. Management of the beetles is costly, and many methods have been ineffective.

Action

Our research includes two different approaches to control Japanese beetles. In 2010, we began a project for classical biological control program against Japanese beetles in north-west Arkansas. After studying densities of beetles at 11 sites around the state, we surveyed Japanese beetle larvae and adults for naturally occurring pathogens and parasitoids. Our study showed that pathogens and parasitoids are currently providing very little control in Arkansas, indicating the need for importation of effective natural enemies. Currently we are focused on a microsporidian (*Ovavesicula* sp.) that has been found effective in controlling Japanese beetles in Michigan. We inoculated turf with infected Japanese beetles to establish the pathogen in Arkansas. We continue to monitor these sites to determine if *Ovavesicula* increases in Arkansas Japanese beetle populations, and helps provide long-term control of the pest. We also are testing new insecticides that may prove more effective and useful for commercial applications, such as golf courses.

Impact

If successful, our project to use biological control to control Japanese beetles will provide economic benefits to Arkansans by permanent reductions in Japanese beetle numbers. Our studies on new pesticides for use against grubs in turf will make it possible for homeowners, golf course managers and turf managers statewide to make informed decisions on chemical control.

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Funding

University of Arkansas Division of Agriculture

Honey bee research

Issue

The honey bee is one of the most important insects in the United States. Its value as a pollinator of many crops is estimated at \$15 billion per year. Beekeepers must deal with many threats to honey bees. The varroa mite and a recent new pest, the small hive beetle, are threats facing beekeepers in Arkansas and elsewhere. Pathogens of honey bees, such as *Nosema ceranae*, have also been implicated in honey bee declines. Arkansas' agricultural infrastructure and food supply requires an abundant, healthy population of these important pollinators.

Action

In 2010, we initiated a project to study the small hive beetle and its pathogens. We are surveying this beetle collected from bee hives to determine if any pathogens exist, and could be used to help control this pest of honey bees. We continue to pursue alternative products to test for efficacy against varroa mites. Our study of the prevalence of *Nosema ceranae* in Ar-

kansas bee colonies indicates that this pathogen is not causing colony collapse in Arkansas.

Impact

Honey bees are of vital importance to the state's agriculture. The results of our study will benefit Arkansas beekeepers and agriculturalists as a whole. Understanding the factors that threaten honey bees will help us to plan and provide control methods for the parasites and diseases of honeybees, such as varroa mite, small hive beetle and *Nosema*.

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California Beekeepers' Association; University of Arkansas
Division of Agriculture

Diversity and distribution of Arkansas Siricidae and their natural enemies: opportunities realized from natural, severe forest disturbances

Issue

Invasive forest insect species are arriving in North American forests at an increasing rate and their impact can be devastating. 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 three physiographic regions of the state, the southern gulf coastal plain, Ouachita Mountains and Ozark Mountains. The European wood wasp, *Sirex noctilio* F., is a wood boring wasp native to Europe. It has been accidentally introduced into pine plantations grown in the southern hemisphere, where it can cause extensive pine mortality. In 2005 *S. noctilio* was found breeding in pines in New York and subsequently other neighboring states. It has not yet been detected in Arkansas, but climate models and host selection studies suggest that if it is introduced it will successfully survive and reproduce in our native pines. 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 woodwasp species.

Action

In North America there are 17 species of siricid woodwasps that colonize *Pinus* spp. as a host resource. They are not pests, or in any way dangerous, but develop and reproduce in the wood of damaged and dying pines. Two species of *Sirex* (*S. edwardsii* Brullé, and *S. nigricornis* F.) are commonly represented in the University of Arkansas Arthropod Museum collection, but little if any comprehensive research on their natural enemy complex, relative abundance or diversity in forests has been conducted. Both of these species have been recorded from most southern states including Arkansas. Because our native species of woodwasps have insects and nematodes that may serve as naturally occurring biological control agents for *Sirex*

noctilio, the more information we have about them prior to their arrival, the more prepared we will be for a rapid response if they are found.

We located field research sites throughout the state of Arkansas, where we have placed traps to catch adult siricids and to monitor their species composition and abundance. We also have created 'trap trees' in which we anticipate native siricids will attempt to reproduce. These trees are being returned to our laboratory and dissected to collect and identify our native *Sirex* species and their natural enemies. We also are dissecting the wasps we collect in order to identify and study the fungi they carry and nematodes that may live within the adult wasps. We are investigating the life histories of siricid species related to *S. noctilio* in order to provide background information to assist in survey and detection, eradication, and if necessary management of this exotic woodwasp species if it should be detected in Arkansas.

Impact

Our research will allow us to understand the biology, distribution and life histories of native and exotic siricids and their natural enemies. We will be able to document flight periods of adult siricids, to define their life histories more completely 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 may discover if loblolly or shortleaf pine have a different complex, or whether the life histories or natural enemy complex differs in either pine species. We may gain new information on the host range of the Asian horntail, *E. formosanus*, which is normally considered to attack deciduous species but which was collected frequently near or at pines in central Louisiana, and which has an uncertain host range that may include pine.

Armed with the knowledge we expect to obtain, we will be that much more prepared in the event of this exotic invasive species arriving in Arkansas.

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USDA Forest Service; University of Arkansas Division
of Agriculture

The recent decline of oak forests and status of the red oak borer outbreak in Arkansas

Issue

Ten years ago, Forest Service pest management specialists discovered tens of thousands of dead and dying red oaks in the forests of northern and western Arkansas. A significant cause of tree mortality in this "oak decline event" was a population explosion of a previously innocuous, native wood-boring beetle, the red oak borer. There was great concern that red oaks would be eliminated from our forests, resulting in greatly changed forest structure and opening the way for more shade tolerant maples to dominate. Oak declines have occurred repeatedly, and often insect or disease outbreaks are indicted

as causes of associated tree mortality, however we learned that red oak borer had never before been indicted as a tree-killing component of an oak decline event. Little information existed to guide research on red oak borer. We began to investigate the biology of the insect, create sampling methods to look at numbers of beetles within trees and in the forest. We believed that it was necessary to understand the causes for this beetle outbreak, how long it might last and what impact it could have on our oak-hickory forests.

Action

From 2001-2010, our team of graduate students, technicians and scientists from the University of Arkansas, including the Center for Advanced Spatial Technologies, along with cooperators from the Arkansas Forestry Resources Center, the USDA Forest Service, and the Universities of Kansas, Missouri, California and Illinois has studied red oak borer and its effects. We felled and intensively examined more than 240 oak trees from the Ozark and Ouachita National Forests. We investigated adult beetle emergence, flight behavior, host tree selection, factors affecting red oak borer populations and how they may influence borer and tree mortality. We examined how trees respond to infestation and investigated the relationship of forest site, stand and tree conditions to the distribution and abundance of the red oak borer outbreak. We developed a series of sampling techniques, specifically designed to estimate beetle densities within trees, within forest stands and across entire forests. We have extended our sampling to historical analysis of red oak borer populations over the past 70 years using current methods of tree ring analysis. We initiated remote sensing and GIS-based studies to visually define susceptible forests and forest conditions associated with increased red oak borer populations and tree mortality. We know now that from 1940 until 1992 red oak borer populations were present in red oak trees but at consistently low levels. The current outbreak on the Ozark National Forest appears to have begun in 1994 and peaked in 2000 and 2002, with population levels more than 100 times higher than at the beginning of the outbreak. Populations began to crash in 2004 and are now nearly as low as before the outbreak began.

Impact

This research explores the contributing role of a previously innocuous wood-boring beetle that acted synergistically with predisposing factors in an oak decline event, and played a key role in killing red oaks in the Ozark and Ouachita Mountains. This is unique in that this native insect species has now assumed a new status as a tree killer, despite it never having been established as a tree mortality factor in over 100 previous oak decline events. Our research efforts have resulted in more new knowledge published on the biology, sampling, impact, and population dynamics of red oak borer than from all previous studies combined. Borer population growth was positively correlated with drought severity, which suggested that drought, an exogenous factor, may have been an important causal factor in the recent outbreak. Endogenous factors, such as maturity of northern red oaks acting at the stand level, were also likely important due to geographic variation in timing of borer

population phases. Our GIS-based hazard models will help predict those forest conditions that will be least susceptible to future red oak borer outbreaks. We are working to develop a web-based spatial decision support tool which forest managers and land owners can use to determine what level of hazard their forest stands exhibit with regard to potential red oak borer outbreaks.

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USDA Forest Service; University of Arkansas Division of Agriculture

Genetic variation of honey bees from honey bee queen breeders in the United States

Issue

Honey bees, *Apis mellifera*, are the principal managed pollinators of agricultural and horticultural crops in the United States. A lack of genetic variation in colonies of honey bees may be a factor associated with Colony Collapse Disorder. The primary source of honey bee queens in the United States is queen breeders. The purpose of this study was to assess honey bees obtained from queen breeders in the United States to determine genetic variation of honey bee colonies.

Action

In this study, we used DNA sequence analysis of a mitochondrial DNA gene. A region of the mitochondrial DNA (mtDNA) cytochrome oxidase I and II (COI-COII) genes was sequenced from 140 colonies from 14 queen breeders in the United States. Analysis by DNA sequence revealed seven different mitotypes from 14 queen breeders in 11 states. Of the seven observed mitotypes, two have not been previously described.

Impact

This is the first study to use mtDNA sequencing analysis extensively on queen breeder colonies in the United States, and our analysis found genetic variation within and among bees provided by queen breeders. However, the levels of mtDNA genetic variation found in these bees is considerably lower than the variation found in feral honey bee populations in the United States. Feral populations may have adaptations to better survive honey bee pests, such as varroa mite and small hive beetle. We suggest that feral populations be used as a source to increase the genetic diversity of honey bees produced by queen breeders in the United States.

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University of Arkansas Division of Agriculture

Managing false smut to reduce yield losses in rice

Issue

False smut of rice, caused by a fungus (*Ustilaginoidea virens*), is an emerging disease in Arkansas and its now found in all of the rice producing counties in the state and beginning to have an impact on yield and quality. It is already one of the most important diseases of rice worldwide. But there is little information available that describes the disease etiology and epidemiology, how the pathogen survives or is dispersed from one location to another, how it survives from year to year, how the fungus infects rice plants and most importantly how to control it or reduce the damage it causes. We are currently addressing two main issues: 1) how does the fungus infect rice, and 2) how can it be controlled with fungicides and or disease resistance. The overall objectives of our research are to determine how the fungus initiates infection of plants and how the pathogen survives to cause disease each year. Secondly, we are searching for resistance to the disease and testing fungicides. Our main goals are also to find an effective chemical treatment that could be used to control the disease until resistance is found.

Action

In 2010 we continued a systematic search for fungicides that inhibited the growth and development of the fungus within plants after it had infected seedlings in the soil by using a molecular technique called polymerase chain reaction (PCR) to 'track' the fungus within asymptomatic plants. The PCR technique amplifies the DNA of the fungus when it is infecting plant tissues and it is an extremely useful and powerful tool that shows how this fungus invades treated plants. We are also testing the conditions in the field that favor development of the disease in order to find optimal conditions for production of the sporophores on rice heads. In 2010 we tested nearly 200 breeding lines in field tests. In one test, we found that the disease was much more severe on one cultivar in one location than in another while the conditions did not affect severity on other cultivars. In addition, we tested a series of fungicides as seed and foliar treatments and measured their effectiveness by growing plants from infested seeds and planting them in infested soils. As a result, we have discovered that one fungicide, registered on another crop, effectively reduced infection of rice by false smut when assayed by PCR or by visual quantitative methods. In 2010, comparative field and greenhouse studies on seed treatments with fungicides across several locations indicate that fungicides applied to seeds prevented infection of seedlings. In 2009 we showed in field tests that false smut was soil-borne because healthy seeds planted in infested soils became infected. In 2010, we showed that false smut is also seed-borne because when we planted infested seeds from infested sources in a field with no history of rice, the rice plants were visibly infected at harvest. Thus, we now know that false smut of rice is both seed and soil-borne.

Impact

False smut is a serious and emerging disease of rice. Our research clearly show how the fungus infects rice and that the fungus is both soil-borne and seed-borne. The disease cycle

is more clearly understood. These results now point directly toward development of more effective and more targeted strategies to manage the disease with fungicides that may reduce the dispersal and importance of an emerging disease of rice in Arkansas. Further, we now have more precise knowledge of the conditions that influence disease severity and can now have a clearer approach to finding disease resistance. These results may also influence how producers grow rice for commercial distribution in fields with a history of this disease.

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

Rubus virus diseases and development of control measures

Issue

Blackberry yellow vein disease and crumbly fruit and decline remain the two most important virus problems for *Rubus* (blackberry and raspberry) growers across the country. Both diseases are caused by virus complexes, the identities of which are not as important as is the sheer number of viruses infecting a plant. The number of viruses associated with the diseases increases continually as does the number of potential vectors in the field.

Action

A consortium of scientists including virologists, entomologists, nematologists and horticulturalists are involved in better understanding the diseases and development of control measures in the field. The approach starts from virus characterization followed by vector identification. As we learn more about viruses and vectors, tailored control protocols for each affected area will be developed to minimize disease impact. In addition, a coordinated effort between virologists and breeders is underway to identify sources of resistance not only to viruses but also their vectors.

Impact

Both diseases have major economic impacts. Because of Blackberry yellow vein disease, the approximate lifespan of a field in the Southeast is 5-7 years in contrast to the 20 years that was the norm just a few years ago. The cost of transplanting is well above \$6,000/acre and plants are not fully productive for the first two years. The price of fruit from plants affected from crumbly fruit and decline are less than 25% of the price of normal fruit. It is obvious that this project can have an economic effect in the tens of millions of dollars upon its completion.

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Funding

USDA Specialty Crops Research Initiative; 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 diverse, involving native and introduced disease pests that can pose both direct and indirect threats to plants in urban settings and agricultural commodities. The urban plant pathology program focuses on education of homeowners, agriculturists, youth, and the professional landscape, turf, and nursery industries.

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 Crew" 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, weed specialist, or wildlife specialist. The wildlife specialist was added for 2009-2010. The Web site had its first full season debut in the spring of 2008, where it received more than 10,000 hits from people in-state and out. Approximately 11,000 hits were received for the months of March-October in 2010 and approximately 2,000 hits for plant disease topics/questions.

Some of the other activities of the program for 2010 include certifying 412 new Master Gardeners trained from all three districts of the state (Ozark, Delta, and Ouachita) for a total of 2,668 Master Gardeners with 113,528 work hours by participants and 76,990 learning hours. There were 15 multi-county Master Gardener disease-related training presentations.

In July 2010, the program joined the AllExperts.com international pool of plant pathology experts. Also in 2010, we began production of 35 Web-based plant disease video segments scheduled for rollout in spring 2011.

Impact

The activities of the urban plant pathology program are specific to Arkansas and its agricultural sector. Plant disease education programs are presented in all interested counties that have an agricultural sector.

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Funding

University of Arkansas Division of Agriculture

Rice policy and market analysis

Issue

The U.S. rice industry provides high quality rice for both domestic and international markets. 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. Baseline 10-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 has been substantially revised to address not only spatial trade flows but also impacts on domestic input demand, production, processing and consumption. This model is particularly useful to evaluate regional trade agreements and transportation and other transaction cost impacts.

We also analyze representative Arkansas rice farms for changes in policy, technology, and market conditions. Farm level analysis provides an important perspective that policy decision makers and the rice industry need to make sound decisions. Research on the 2008 Food, Conservation and Energy Act proposals has focused on the impact of changes that may be forthcoming in the 2012 farm bill, which will be subject to

much greater fiscal and budgetary pressures. More recently, the rice economics research program has also used a computable general equilibrium CGE model of the global rice economy using the GTAP framework to capture impacts of policy changes not only on the rice product market but also related commodity market and input factor markets such as labor and capital.

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 (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. Research using stochastic methods on new provisions in the 2008 farm bill found that Arkansas farmers would not be better off by switching to the new ACRE revenue assurance program away from traditional payment support programs. Rice farms in Arkansas were estimated to have higher revenue under the ACRE program in the range from only 6 to 27 times out of 100 likely scenarios.

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Funding

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

Price impact of LibertyLink 601 genetically modified rice contamination

Issue

Import bans or restrictions of genetically modified (GM) agricultural commodities have occurred in both Europe and some Asian countries, such as Japan and South Korea. In the past few years, intrusions of unauthorized GM products into commercial markets have led to a further decline in public support for GM foods. These unexpected GM contaminations

have caused significant financial losses to the U.S. agricultural sector, and have negatively affected the incomes of U.S. farmers, traders, and retailers. On 18th August 2006, the USDA announced that unapproved LibertyLink 601 GM rice, a product of Bayer CropScience, had been found in U.S. rice supplies destined for human consumption and export. Following that announcement, U.S. rice trade was stopped or disrupted to the EU, Mexico, Japan, Taiwan and other markets; and an estimated 63% of rice exports were affected by certification, testing, labeling or outright bans. On the day of the announcement, prices of long-grain rice futures contracts traded on the Chicago Board of Trade began to decline, and fell by nearly 10% in the following two days. Consequently, rice growers, harvesters, processors, millers and retailers all have claimed that they have suffered serious losses. Many farmers have filed lawsuits against Bayer to recoup their losses and litigation is ongoing.

Action

Researchers used an event-study model to assess the immediate price impact of the LL601 contamination event. Results indicated that by Monday August 28th rice futures prices were 17.09% lower than they would have been if the contamination had not occurred. This research was published in the *Journal of Agricultural and Applied Economics* in 2010.

Impact

This research has played an important role in helping participants in the rice market measure the price impact of the contamination and the *Journal of Agricultural and Applied Economics* article has been frequently cited in subsequent damages litigation.

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University of Arkansas Division of Agriculture

Economic optimum nitrogen rates for rice in Arkansas

Issue

Nitrogen (N) is a major input of rice production and accounts for approximately 19% to 25% of total variable production expenses for rice, depending on the soil texture. Nitrogen prices were at record highs in 2008, with U.S. Gulf urea prices averaging \$463/ton and ranging from \$191 to \$753/ton for that year. The recently high volatility of fertilizer prices has led to increased desire among rice farmers to apply N optimally in the most profitable amounts. Nitrogen application also has

environmental implications. Over-application of N can lead to nitrate contamination of water.

Action

This study uses data from the Variety by N Fertilizer Rate Study conducted annually by the University of Arkansas. Yield by N data were collected for public rice varieties (non-hybrid, non-Clearfield varieties) from four research locations for the period 2001 through 2008. The four research locations were: 1) the Southeast Research and Extension Center (SEREC) near Rohwer, Arkansas; 2) the Northeast Research and Extension Center (NEREC) at Keiser, Arkansas; 3) the Rice Research and Extension Center (RREC) near Stuttgart, Arkansas, and 4) the Lake Hogue Research Farm (LH) near Weiner, Arkansas. Soils at the SEREC and NEREC locations are classified as clay soils, while soils at the RREC and LH locations are classified as silt loam soils. The Maximum Return To N (MRTN) method was used to determine economically optimal N rates for each location. The MRTN method is a numerical method requiring estimation of yield response functions by site/year to estimate yields by site/year in 1 lb N ac⁻¹ increments. Returns to N are calculated for each N rate and are averaged across years for each site, and the N rate with the largest average return is defined as the Economic Optimum N rate (EON). The MRTN method also allows the user to identify N rates above and below the EON rate for which returns to the producer do not differ appreciably. The MRTN method was used in this study to determine EON rates and the range of profitable N rates producing net returns within \$1.00 ac⁻¹ of the maximum return for each research location.

Impact

Economic optimum N rates and profitable N ranges by location are as follows assuming average 2006-2008 rice price and N cost data and annual quadratic yield response to N functions: 134 lb ac⁻¹, 128 to 140 lb ac⁻¹ at the RREC; 109 lb ac⁻¹, 103 to 115 lb ac⁻¹ at LH; 162 lb ac⁻¹, 155 to 169 lb ac⁻¹ at the NEREC; and 167 lb ac⁻¹, 161 to 174 lb ac⁻¹ at the SEREC. How do these EON rates and profitability N ranges compare with University of Arkansas nitrogen recommendations for public rice varieties? Nitrogen price sensitivity analysis revealed that current University of Arkansas nitrogen recommendations are within the acceptable profitable N range limits calculated above for the RREC (silt loam), NEREC, (clay) and SEREC (clay) locations when N prices are at low to mid price ranges but call for more N than required at the LH (silt loam) research location. Rice yield potential is lower for the LH location than for the other three locations, and EON rates and profitable N ranges for the LH location are also lower.

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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 no-till 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 former produced a mean of 7.4 tons/acre of dry biomass, compared with a mean of 3.0 tons/acre in the latter location. We modified the ALMANAC crop growth model to more accurately predict biomass yield of switchgrass in the late summer-autumn period. In the second year of trials, biomass yields were significantly increased by applying increasing rates of poultry litter or urea fertilizer to switchgrass. Six herbicide treatments were identified that resulted in greater than 90% ground cover and high biomass yield at the end of the second year. The first year's harvest was taken from a multi-year trial involving switchgrass and cottonwood intercropping, with yields ranging from 1.3 to 3.0 tons/acre.

Impact

The large difference in biomass yield between the two test sites indicates that root restriction and low subsoil fertility likely limited switchgrass yields, even at four years after establishment. Growth curve data indicated that removal of nitrogen, phosphorus, and potassium from the field is greatly reduced by delaying harvest past August. Such information allows planning of harvest dates to minimize the amount of fertilizer needed to sustain high yields. The modified ALMANAC simulation model can predict biomass yield in other locations in Arkansas. This tool will be useful for a future bioenergy industry to plan the location and timing of harvests to meet biofuel production needs. Biomass of switchgrass when intercropped with cottonwood allows landowners to receive income off the land during the years before the trees are ready to harvest.

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Rice educational approaches evolve**Issue**

Conditions for rice production were less than ideal during 2010. Optimum planting weather led to record acreage planted about 3 weeks ahead of normal. However, heat and drought that followed resulted in significant crop failures due to inadequate irrigation water and high incidence and severity of bacterial panicle blight. The heat, particularly high nighttime temperatures, was also responsible for overall reduced yield and reduced milling yield. While the state average yield of 144 bu/acre was less than any year since 2000 and certainly less than the 161 bu/acre record, the yield was higher than any yield prior to 2000. In spite of the weather adversity, variety development and rice management have allowed many growers to still produce good rice yields.

Action

Rice educational programs have included traditional means such as county production meetings, newsletters, and fact sheets for several years. As the clientele have become more dependent upon electronic access to data and social media, an opportunity was presented to expand the educational methods with which we have become familiar. We initiated the use of social networking and internet blogging as an additional means of providing access to unbiased recommendations.

Educational information was posted to a blog and then also posted on a Facebook fan page and a Twitter page. One of the advantages of these opportunities has been the access to non-conventional audiences.

Impact

We have had over 4,000 visits to the blog, we have 65 followers in Twitter and 455 following on Facebook who receive information weekly during the growing season. This technology has not only allowed us to meet the needs of traditional clientele, we have also been able to reach the technologically savvy client base and the numbers continue to grow each week. An additional, yet unexpected, impact has been the ability to reach non-traditional clientele. While the history of this program is to provide timely production technology information to growers, consultants, and agricultural industry representatives, the use of social media has allowed us to reach everyday citizens that are not directly involved in the agriculture business. The general public's awareness of the importance of agriculture in this country for their food supply is declining. This technology has allowed us to reach a new audience and be able to highlight the contribution of rice production to the U.S. economy and food supply.

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Funding

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A Healthy Well-Nourished Population

Elimination of alum from fermented cucumber pickle products

Issue

Aluminum salts (alum) are commonly used during commercial processing to improve firmness and crispness of fermented cucumber pickle products. The aluminum ions (Al) bind to cell walls, which strengthens the pickle's structure. Without the alum treatment, pickle products usually soften during storage which adversely affects consumer acceptance; however, residual Al that ranges from 25 to 125 ppm in products also adversely affects acceptance by some restaurants such as McDonalds and some consumers. Therefore, methods are needed to provide firmness and crispness of pickles without the use of alum.

Actions

Research was established in the University of Arkansas Division of Agriculture Department of Food Science, along with the collaboration of pickle manufacturers to identify a treatment that eliminated alum for creating and retaining desirable textural characteristics of fermented pickle products. The ultimate goal was to develop a treatment that retained an alum-like or better texture during storage for one year without the use of alum. Several fermentation and processing treatments were screened in laboratory trials and a few that had favorable results were examined by industry representatives. Eventually the most promising treatment was identified which was elevation of calcium during fermentation to about 0.3%, an amount that was three times the normal amount commercially used. Following this discovery, scale-up trials were performed by pickle manufacturers and samples of products were examined by a sensory panel, food distributors and consumers.

Impact

The treatment of cucumbers with 0.3% calcium during fermentation was rapidly implemented by some pickle manufacturers since it eliminated the need to use alum for providing and retaining desirable firmness and crispness textural qualities. This treatment has allowed marketing of pickle products to food service enterprises and consumers that do not want additional Al in their foods without compromising textural characteristics. An additional impact that has yet to be exploited is the additional amount of residual calcium that is in the pickle products produced by this treatment.

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Evaluation of dietary supplement safety

Issue

Dietary supplement use, which includes vitamin and mineral products and botanicals, remains popular in the United States and worldwide. 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 allow 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. 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 benefited 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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Peptide fractions derived from high oleic acid soybean lines inhibit the growth of many human cancer cell lines

Issue

Currently available therapeutic methods to treat diseases like cancer and heart disease are expensive and have the risk of causing severe side effects. Hence, natural and alternative medicine is sought for treating these age-related chronic diseases. For example, soybeans are a major source of quality protein from oil-extracted meals that are abundantly available and inexpensive (\$0.5-\$0.7/lb). Furthermore, high oleic acid soybean lines have become popular among growers in the United States due to their high quality oil in the seeds. Higher production of these soybean lines leads to higher yields of oil-extracted meal, and it is essential to explore value-added uses for these soybean meals that are co-products of a larger process. Studying the anticancer effects of the bioactive compounds isolated from these soybean meals could drive towards natural alternative means of disease management, and also have an economic impact in utilization of this co-product.

Action

Soybean meal was prepared from the seeds of selected high oleic (N09-4445A, S03-543CR) and high protein (R95-1705) soybean lines; protein was extracted and hydrolyzed with an endoprotease, alcalase, under optimized conditions to yield smaller size (<50 kDa) peptides. The peptides were tested for gastro-intestinal juice resistance (to prevent breakdown during digestion process when incorporated into food products) and fractionated with ultrafiltration into <5 kDa, 5-10 kDa and 10-50 kDa molecular sizes and tested for bioactivity against human colon, liver, lung, breast, prostate and blood cancer cell lines.

Impact

The significant impact of this research is the utilization of an inexpensive high quality oleic acid and protein rich soybeans with the potential to provide biologically active peptide fractions that have multisite anti-cancer activities. These bioactive peptides can be incorporated into food products as ingredient formulations thereby serving as natural alternatives from a food source against expensive therapeutic treatments. Research in bioactive peptides can lead to commercial interest in utilizing the soybean meals for their nutraceutical potential, which would be advantageous to Arkansas agriculture and the soybean industry.

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Soybean Board; University of Arkansas Division of Agriculture

Enhanced bioactivity of glycosylated pentapeptide isolated from rice bran

Issue

Chronic diseases account for 7 of every 10 deaths and affect the quality of life of nearly 90 million Americans each year. Cancer remains as the second leading cause of death in the United States. The challenge is to find suitable natural alternatives that can function as nutraceutical agents in reducing the risk and preventing disease pathogenesis in such chronic conditions. There is hence a need to add value to inexpensive co-products that are natural anti-cancer agents.

Recent research has resulted in characterizing a pentapeptide (EQRPR) from rice bran for multiple-site activity against cancers. This peptide was found to be potent at ~800 µg/mL in reducing ~80% of cancer cell growth. Glycosylating the peptide for enhanced bioactivity has been the novel approach to generate more bioactivity to the peptide.

Action

Specific amino acid residues can be modified using physical or chemical treatments. Based on the amino acids in the peptide, and considering physical factors that may influence modification, a response surface design was devised to modify the peptide (glycosylation) to an optimal level. The varying degrees of glycosylated peptide at different physical parameters (pH, relative humidity (RH), and temperature) were tested on colon and liver cancer cells for bioactivity enhancement. Nano-packaging by developing nanoparticle-encapsulated peptides is under investigation for effective delivery of peptide.

Impact

This study will be able to generate for the first time a pentapeptide (modified) to function as a bioactive agent to control certain key pathogenic events in chronic diseases. A huge application for the peptide in both free and modified form exists, especially in product applications where the peptide can be nano-packaged to deliver effective concentrations for bioactivity. Data obtained from the study will be useful to explore possibilities of incorporating the peptide into food products and further studies on bioavailability and absorption using animal models. Thus, a naturally derived pentapeptide from a cheap co-product obtained from processing of rice can be utilized as a bioactive nutraceutical agent that can be beneficial against certain human chronic illnesses.

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Arkansas Biosciences Institute; University of Arkansas
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Release of bound procyanidins from cranberry pomace by alkaline hydrolysis

Issue

Cranberries are growing in popularity due to their high content of procyanidins and ability to prevent urinary tract infection. Polyphenolics found in cranberries are also thought to confer additional health benefits through antioxidant, anti-tumor, antiulcer, anti-inflammatory and anti-atherosclerotic activities. Cranberry pomace, the residue remaining from the juicing and canning processes, contains seeds and skins, the source of the polyphenolics responsible for health benefits associated with the berries. Unfortunately, the procyanidins in cranberries as well as other berries have a strong affinity for cell wall polysaccharides and are not released by normal extraction methods.

Action

This study evaluated the efficacy of sodium hydroxide treatment in releasing procyanidins from cranberry pomace. The optimal alkaline hydrolysis conditions to liberate procyanidins and depolymerize large molecular weight polymers from dried cranberry pomace were identified. Alkaline hydrolysis resulted in an increase in low molecular weight procyanidins and the increase was greater at higher temperature, short time combinations. When compared to conventional organic solvent extraction, treatment with sodium hydroxide increased procyanidin monomers and dimers by 15 and 8-fold, respectively. Additionally, alkaline extraction of the residue remaining after conventional organic solvent extraction resulted in further procyanidin extraction, indicating that procyanidins are not fully extracted by conventional extraction methods.

Impact

The alkaline hydrolysis method developed has several important applications. 1) It can be used to estimate the amount of bound procyanidins in plant materials, 2) It can be used to increase levels of the small molecular weight procyanidin monomers and dimers (which are bioavailable) at the expense of the large molecular weight polymers (which are not bioavailable), and 3) It can be used industrially to recover procyanidins from waste materials to be used in dietary supplements or for fortification purposes.

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Arkansas Biosciences Institute; University of Arkansas
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Proximate and polyphenolic characterization of cranberry pomace

Issue

Cranberry pomace is the by-product of the cranberry processing industry and is composed of skin, seeds, and stems, which remain after the fruit has been pressed for juice or prepared for canning. Applications for cranberry pomace are limited as its low protein content makes it unsuitable for animal feeds, and its low pH presents problems when it is disposed of in the soil. It is important to the cranberry processing industry that alternate uses of cranberry waste material be evaluated. Cranberries have received much attention due to their health benefits, especially their ability to prevent urinary tract infections. These benefits are thought to be due to the presence of various polyphenolic compounds such as procyanidins, anthocyanins, and flavonols. Since these compounds are localized in seeds and skins of cranberries, cranberry pomace should be explored as a source of health-benefiting polyphenolic compounds.

Action

Proximate analysis of dried cranberry pomace was conducted based on American Organization of Analytical Chemists (AOAC) methods for moisture, protein, fat, dietary fiber, and ash, with other carbohydrates determined by the difference method. Polyphenolic compounds were identified and quantified by high performance liquid chromatography (HPLC)-electrospray ionization (ESI)-mass spectrometry (MS). The composition of dried cranberry pomace was 4.5% moisture, 2.2% protein, 12.0% fat, 65.5% insoluble fiber, 5.7% soluble fiber, 8.4% other carbohydrates, 1.1% ash, and 0.6% total polyphenolics. Six anthocyanins (115.5 mg/100g DW) including derivatives of cyanidin and peonidin were present. Thirteen flavonols were identified (146.2 mg/100g DW), and the aglycones myricetin (55.6 mg/100g DW) and quercetin (146.2 mg/100g DW) were the most prominent. Procyanidins with degrees of polymerization (DP) of 1-6 were identified (167.3 mg/100g DW), the most abundant being an A-type of DP2 (82.6 mg/100g DW).

Impact

Cranberry pomace is an excellent source of dietary fiber and polyphenolics, especially procyanidins and flavonols. The abundance of A-type procyanidin oligomers and myricetin and quercetin aglycones in the pomace may be important for health as A-type oligomers are thought to be the compounds responsible for preventing urinary tract infections by inhibiting bacteria from adhering to the epithelial lining of the urinary tract, and quercetin has purported anti-cancer and anti-heart disease activities. Our results indicate that cranberry pomace shows great promise as a functional food ingredient or nutraceutical product.

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Polyphenolic composition and antioxidant capacity of extruded cranberry pomace

Issue

Cranberry pomace, a waste product from cranberry processing consisting of skin, seeds, and stems, is a rich source of polyphenolics such as anthocyanins, procyanidins and flavonols. Cranberry polyphenolics are recognized for their health benefits including reduced risk of cancer, cardiovascular disease, and prevention of urinary tract infections. Hence, cranberry pomace has potential as a nutraceutical extract or functional food product. Extrusion is a popular food processing technique especially in the cereal and snack food industry, and is capable of preserving desirable food components and destroying microorganisms. Extrusion presents mechanical stress in the form of heat and shear to the food, which may alter physical as well as chemical characteristics of the product. The goal of this research was to determine the effect of extrusion processing on the polyphenolic composition and antioxidant capacity of cranberry pomace mixed with corn starch.

Action

Cranberry pomace was mixed with corn starch in various ratios (30:70, 40:60, 50:50 pomace/corn starch dry weight) and extruded using a twin-screw extruder at three temperatures (150, 170, and 190 °C) and two screw speeds (150, 200 rpm). Changes in anthocyanin, flavonol, and procyanidin contents were determined by high performance liquid chromatography (HPLC). Antioxidant capacity of the extrudates was determined using oxygen radical absorbance capacity (ORAC). Anthocyanin retention was dependent on barrel temperature and percent pomace. The highest retention was observed at 150 °C and 30% pomace. Flavonols increased by 3-34% upon extrusion compared to an unextruded control. The ORAC values increased upon extrusion at 170 and 190 °C. An increase in DP1 and DP2 procyanidins was observed at the expense of DP4-DP9 oligomers indicating depolymerization of large molecular weight procyanidins occurred in response to extrusion.

Impact

Although extrusion of cranberry pomace resulted in losses of anthocyanins, it increased flavonols and low DP procyanidins, while decreasing DP4-9 procyanidins. The conversion of high DP procyanidins to low DP forms is encouraging since only the smaller monomers and dimers are bioavailable. Applications for this research could provide a use for the waste product of cranberry juicing, which currently has little functionality due to its low protein content and pH. Furthermore, it could lead to improved functionality of polyphenolic compounds, particularly procyanidins and flavonols. The resulting product could be incorporated into a dietary supplement or explored as a functional food ingredient.

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Cranberry pomace partially ameliorates metabolic factors associated with high fructose feeding in growing Sprague-Dawley rats

Issue

Cranberry pomace, the by-product of cranberry processing, can account for up to 20% of the initial fruit weight. The pomace is a rich source of polyphenols including anthocyanins, procyanidins, and flavonols, since the compounds are concentrated in the skins and seeds of the fruit and are retained in the pomace. Cranberries are one of few foods that contain A-type procyanidins, which have been linked to the prevention of insulin resistance and are also suggested to be the active components responsible for the prevention of urinary tract infections. We have previously demonstrated that extrusion processing of fruit by-products such as blueberry, grape and cranberry pomace can enhance the low molecular weight procyanidins that are bioavailable at the expense of some of their large molecular weight counterparts that are not readily absorbed. The goal of this research was to investigate the effect of feeding cranberry pomace on different metabolic characteristics associated with metabolic syndrome in high-fructose-fed growing rats.

Action

The effect of feeding cranberry pomace on selected metabolic parameters associated with high-fructose feeding (58% by weight) was investigated in growing Sprague-Dawley rats. Compared to a positive control (modified AIN93 diet) high-fructose feeding increased fasting plasma insulin, cholesterol, and triacylglycerols (TAG), post-prandial plasma TAG as well as homeostatic assessment models of insulin resistance and β -cell function, but not weight gain, diet intake and efficiency, abdominal fat, oral glucose tolerance, and fasting and post-prandial plasma glucose and cholesterol levels. Inclusion of cranberry pomace was effective in minimizing or ameliorating some of the metabolic anomalies, such as increased fasting plasma insulin, cholesterol, and TAG level as well as decreasing insulin resistance, especially when extruded cranberry pomace was fed at 3% of the diet. Feeding high fat diets was only partially effective in augmenting some of the metabolic factors associated with high-fructose feeding, including triacylglycerolemia and insulin resistance, but not weight gain or abdominal obesity.

Impact

Inclusion of 58% fructose in the purified diet did not produce a strong response in some of the metabolic parameters associated with metabolic syndrome in growing Sprague-Dawley rats such as weight gain, accumulation of abdominal

fat, and increase in fasting plasma glucose. We suspect these young animals can adapt better to the nutritional intervention without developing some of the classical signs of positive energy balance, abdominal fat secretion or glucose intolerance that are associated with metabolic syndrome, but yet manifest some other metabolic parameters such as higher plasma TAG, increased insulin resistance, or elevated plasma insulin levels. Both extruded and unextruded cranberry pomace were effective in mitigating or minimizing some of the negative effects of high-fructose feeding with the greatest protection provided by extruded pomace at 3% of the diet. Further investigation is needed to determine the individual polyphenols present in cranberry pomace that may be responsible for improvements in metabolic parameters.

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Anti-colon cancer effect of soy saponin fractions in soybean

Issue

Colorectal cancer (CRC) is the third most commonly diagnosed cancer in the United States, causing an estimated 49,920 deaths in 2009. The lifetime risk of being diagnosed with cancer of the colon or rectum is 5.5% for men and 5.1% for women in the U.S. Remarkably, only 20-25% of CRC cases occur among individuals with a family history of CRC or a predisposing condition and the remaining 75% of cases occur in people without these risk factors.

Action

The effects of two elicitors sprayed at different growth stages and different concentrations on saponin contents of soybean seeds were evaluated. Soyasapogenol B will be produced by acid hydrolysis. Saponin fractions will be isolated from soybeans that were grown as part of a study. Soyasapogenol B and saponins will be used to examine the anticarcinogenic activity. Animal study will be conducted to evaluate the *in vivo* effects of soyasapogenol B and saponins on colon cancer incidence and determine the bioavailability of soyasapogenol B and saponins. The use of soyasapogenol B and saponins can reduce biomarkers and incidence of colon cancer.

Impact

The findings of the study will bring forth evidence that saponin fractions in soybeans can help prevent colon cancer incidence. Soy might become a much more important part of the U.S. diet if saponin fractions are demonstrated to be effective in the prevention of chronic diseases. It could increase market-driven diversification in agriculture, to the benefit of state economies.

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Effect of group B soyasaponins and soyasapogenol B on cholesterol concentrations

Issue

Atherosclerotic cardiovascular disease (CVD), principally coronary heart disease (CHD) and stroke, is the leading cause of death in the United States, accounting for more than 38% of all deaths (1 in every 2.8 deaths). In 2009, estimated direct and indirect cost of heart disease and stroke is about \$165.4 billion and \$68.9 billion, respectively. Elevated plasma cholesterol, specifically total cholesterol (TC) and low density lipoprotein cholesterol (LDL-C), and decreased high density lipoprotein cholesterol (HDL-C) concentrations are directly associated with an increased risk for coronary heart disease and other sequelae of atherosclerosis.

Action

A study was conducted in hamsters to determine if group B soyasaponins and soyasapogenol B affect plasma lipid concentrations. Forty-eight hamsters were assigned to one of four dietary treatment groups and fed for 4 weeks: 1) low fat control (LFC), 2) high fat control (HFC), 3) high fat diet with soyasapogenol B (SPG), and 4) high fat diet with group B soyasaponins (SSP). The LFC group was significantly lower in all cholesterol measurements. Total cholesterol in the SPG and SSP groups was lower than the HFC, but not significantly lower. Triglyceride levels in the SPG and SSP groups were not significantly different compared with the HFC and the LFC groups. The SPG group was shown to decrease non-HDL levels compared to the HFC group. Compared to SSP, the SPG group further decreased cholesterol levels suggesting that the sapogenol (aglycone) form may be more bioavailable than the saponin (glycosidic) form.

Impact

The market for functional foods as health enhancing products is rapidly expanding. Because group B soyasaponins and soyasapogenol B from this research will provide additional information of phytochemicals in soybeans, the findings of this research will further enhance the marketability and status of soy as a functional food, and increase the consumption of soy and soy products.

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EPSCoR-AR P3 Start-up fund; University of Arkansas
Division of Agriculture

Effect of elicitors sprayed at different reproductive stages on saponin and isoflavone contents of soybean

Issue

A great deal of attention has been focused on the health-promoting benefits of using soy and soy products for their hypocholesterolemic activity, anticarcinogenic activity, antiatherosclerotic activity, and improvement of bone loss. It has been suggested that bioactive components of soybean, isoflavones and soyasaponins are responsible for the beneficial effects of soy.

Action

A study was conducted to investigate the effect of elicitors sprayed at different growth stages and different concentrations on isoflavone and saponin contents of soybean seed (variety Ozark). Elicitors ethyl acetate (EA; 0.001 and 0.1 M) and methyl jasmonate (MJ; 0.001 and 0.005 M) were sprayed at reproductive stages R1–R2 (beginning bloom to full bloom), R3–R4 (beginning pod to full pod), R5–R6 (beginning seed to full seed), and R7–R8 (maturity) stages. Soybean seeds were ground, passed through a 60 mesh sieve, defatted, and isoflavones and saponins were extracted and analyzed with high performance liquid chromatography (HPLC).

Impact

The findings of this study will help in improving total and specific isoflavone and saponin contents by selecting elicitors, concentration, and appropriate application stage. It will provide efficacy for soy breeders and producers in developing soybean lines with nutraceutical and pharmaceutical utilities.

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Arkansas Biosciences Institute; University of Arkansas
Division of Agriculture

Anti-diabetes efficacy of a novel rice product in humans

Issue

Diabetes has been a major health issue in the United States. The prevalence of diabetes is significantly associated with age and race. The diabetes' prevalence for people 45 years or older is four times of that of people under 45 years old. The diabetes prevalence among African Americans (9.7%) is significantly higher than it is among white people (7.1%). Diabetes is the 4th leading cause of death among African Americans, while it is the 6th leading cause of death in Arkansas. Diabetes is a much more pronounced health problem for African Americans than it is for other populations, such as whites, Hispanics and others.

Action

We are evaluating the efficacy of consuming a novel rice product on blood glucose concentrations in humans. The subjects will ingest our slowly digestible starch/resistant starch diet (for experimental group) and a normal diet (the control group). We will be measuring the blood glucose level from subjects at 0, 15, 30, 45, 60, 75, 90, 120, and 180 minutes after ingestion of the diets. Based on those data, we will be able to calculate the incremental AUC (Area Under the Curve) for blood glucose. We expect that the average AUC of our control group is statistically higher than that of our experimental group.

Impact

Rice is a vital crop to Arkansas, accounting for over 50% of total U.S. rice production. The finding of this study will tap Arkansas' rich agrobiological resource in the formulation of a health-promoting rice product with high slowly digestible or resistant starch content and benefit consumers through the prevention or treatment of chronic diseases.

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Division of Agriculture

Efficacy of fresh and processed blackberries in alleviating the complications associated with obesity

Issue

Obesity is a major health problem in the U.S., yet there are no proven, long-lasting, and widely applicable approaches to weight loss. In the U.S., it is estimated that between 280,000 and 325,000 deaths a year are attributed to obesity. Excess weight is associated with numerous diseases and conditions including cardiovascular disease, diabetes, hypertension, osteoarthritis, sleep apnea, gall bladder disease, and some cancers.

Action

A study will be conducted to determine to what extent major anthocyanins of blackberries are degraded by rat cecal microorganisms. Rat cecal samples will be transferred to incubation test tubes containing anaerobic Brain-Heart Infusion (BHI) media. The major compounds present in blackberries will be dissolved in dimethyl sulfoxide and added to a cecal suspension. The cecal suspension will be sampled from each tube at time 0, 1, 3, 6, 12 and 24 hours. Anthocyanins and their metabolites will be extracted and analyzed with high performance liquid chromatography.

Impact

The findings will help us understand how these beneficial components exert health effects in humans. Furthermore, this work will enhance commercial interests and benefit the food industry.

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Funding

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

Effects of fresh and aged blackberry puree on adipogenesis *in vitro*

Issue

Obesity has become an epidemic in the United States as the proportion of overweight and obese adults and children continues to rise. This trend has alarming health implications as obesity is associated with serious health conditions such as heart disease and diabetes. Maintaining a healthy weight through exercise and consumption of foods low in caloric density such as fruits and vegetables is essential to reduce incidences of obesity. Blackberries are one such food; however, due to limited shelf life and seasonal availability, blackberries are consumed mostly in a processed form which may cause degradation of their beneficial compounds.

Action

Adipose tissue growth occurs via two mechanisms 1) increasing the size of mature fat cells (adipocytes) and 2) the differentiation of preadipocytes into adipocytes. In these experiments, the effects of processing and storage on the ability of blackberry puree to affect adipocyte differentiation was investigated. As such, 3T3-L1 preadipocytes were exposed to blackberry puree, both fresh and aged and allowed to differentiate. The levels of two important transcription factors for adipogenesis were monitored and total triglyceride levels were determined.

Impact

Medical costs associated with obesity are estimated to be \$147 billion annually. Improving the processing methods of seasonally available fruits and vegetables in ways that maintain beneficial, fat-fighting compounds may go a long way in reducing these costs. Examining the effects of both fresh and aged blackberry puree on adipocyte differentiation may significantly impact blackberry processing methods towards processes which do not disturb the integrity or availability of the bioactive compounds. Also, understanding the effects of blackberry puree on adipocyte differentiation will provide insight into molecular mechanisms by which blackberries may affect adipogenesis and ultimately obesity.

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Investigation of the molecular mechanisms of chemoprevention of probiotic fermented milk

Issue

Colon cancer is the third most common type of cancer and is the second most deadly. In 2008, the National Cancer Institute estimated over 148,000 new cases of colon cancer were detected. In this same year, nearly 50,000 deaths were attributed to colon and rectal cancers. A strong link exists between colon cancer and diet, and consumption of low-fat dairy products has been associated with a decrease in colon cancer risk. Probiotic bacteria, present in fermented dairy products such as yogurt have also shown positive association for lower incidences of colon cancer. Despite the purported benefits of probiotic bacteria, little information is available regarding the molecular mechanisms of chemoprevention.

Action

Probiotic bacteria have demonstrated the ability to produce conjugated linoleic acid (CLA) during fermentation of linoleic acid in milk, and CLA has promising anti-cancer potential. Therefore various strains of probiotic bacteria were grown in broth and milk with and without added linoleic acid and the fermentation products were collected and analyzed for their CLA content. The fermented milk was also added to HT29 colon cancer cells and monitored for its ability to prevent proliferation of these cells. The molecular mechanisms of inhibition of proliferation were also examined.

Impact

The global economic impact of colon cancer is estimated to be ~\$99 billion. Probiotic bacteria are thought to produce anti-cancer compounds, and identifying these compounds will help establish mechanism(s) for specific health benefits from consumption of probiotic cultures. In addition, it will provide a scientific-based rationale for selecting and optimizing probiotic cultures and dietary choices for predictable nutritional management to maintain colonic health. Ultimately, isolating and purifying these potential dietary therapeutic molecules could allow future development of nutritional supplements to promote colonic health, reduce the risks of developing colon cancer, and reduce the economic impact of colon cancer.

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Arkansas Biosciences Institute

Childhood obesity and happiness

Issue

Childhood obesity is a very important issue in many countries. Our objective was to assess the relationship between fast food and soft drink consumption as well as the extent to which

these consumption behaviors may affect children's obesity and subjective wellbeing or happiness. Understanding the effects of factors that are correlated with children's body weight and their psychological/mental health is crucial in that if the reduction in children's body weight improves their physical health, the decrease in the likelihood of subjective wellbeing (i.e., happiness) may result in an adverse effect on their psychological or mental health. Hence, policies and programs that aim to improve children's overall health should take these effects on children's objective (i.e., obesity) and subjective (i.e., happiness) wellbeing into account.

Action

This study took a different approach than many previous studies. It used a mixed structure simultaneous-equation system to examine the effects of factors that are associated with children's fast food and soft drink consumption, and the likelihood of being overweight, and unhappy. They looked at the fast food and soft drink consumption, body weight, and level of happiness of 2366 children aged between 2 and 12 years old. Fast food included French fries, pizza, and hamburgers; soft drinks included soda and other sugar-sweetened beverages.

Impacts

The study's key finding was that children who ate fast food and drank soft drinks were more likely to be overweight, but they were also less likely to be unhappy. The authors' analysis also highlighted a number of factors influencing children's body weight, eating patterns and happiness. For example, mothers' consumption of fast food and soft drinks significantly influences her child's eating habits. Those children who ate fast food were more likely to also consume soft drinks. Children from lower income households were more likely to have unhealthy dietary habits and be overweight or obese. Their findings generally suggest that consumption of fast food and soft drinks can result in a trade-off between children's objective (i.e., obesity) and subjective (i.e., unhappiness) well being. Policies and programs that aim to improve children's overall health should take these effects on children's objective and subjective well-being into account to facilitate the reduction in childhood obesity without sacrificing children's degree of happiness.

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Incorporating conjugated linoleic acid-rich soy oil in the diet to reduce heart disease and diabetes risk factors

Issue

Dietary conjugated linoleic acid (CLA) is well recognized for its ability to protect against obesity related diseases. Three grams of CLA/day is proposed to be needed to obtain the optimal human health benefit. However, conventional CLA

food sources such as beef and dairy contain low levels of CLA at 0.2-2% in milk-fat or beef-fat. Obtaining this level of CLA from naturally occurring sources of beef and dairy products would produce an unhealthy increase in dietary saturated fat and cholesterol increase. Production of foods with more CLA with low saturated fat and no cholesterol would promote a healthier diet. High CLA oil is being produced from soy oil, which is naturally composed of 50% linoleic acid (LA), by converting LA to CLA. The challenge is to incorporate this CLA safely into food acceptable to consumers.

Action

We previously produced a 20% CLA-rich soy using ultraviolet light to convert soy oil LA to CLA. We have subsequently increased the CLA levels during processing by adding food additives that promote health and well being. Furthermore, studies have shown that potato chips and salad oils produced from CLA-rich soy oil are as shelf stable as similar products using conventional soy oil. The CLA oil is stable under frying conditions. In addition, we have produced a 100% CLA concentrate which is composed of the most common form of CLA found in CLA-rich oil which could be used as a dietary supplement or pharmaceuticals.

Impact

Half an ounce of CLA-rich salad oil or an ounce and a half of CLA-rich potato chips will provide the 3g of CLA needed to obtain its benefits. In contrast, an 8 ounce serving of beef or milk will only provide 0.27g and 0.06g of CLA. A major U.S. soy company is working to move soy CLA-rich oil production for food use towards commercialization.

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

Parboiled rice as a good source of health promoting starch

Issue

Obesity is a major public health concern affecting more than one-third of adults in the United States. The obesity rate in Arkansas is 30.5% in 2009. Obesity is associated with serious health conditions, including cardiovascular disease, hypertension, diabetes mellitus, and certain cancers. There is an increased interest from consumers in buying foods with purported health benefits. Research has shown that consuming low glycemic index food can be used in weight management and in the prevention and management of type II diabetes. Rice is one of the most important crops in the world, and Arkansas is the largest rice producing state in the U.S. accounting for over 50% U.S. rice production. Rice provides a major source of carbohydrates for many countries.

Action

Food science researchers at the University of Arkansas demonstrated that parboiled rice is a good source of health-promoting starch, i.e. slowly digestible starch and resistant starch. Resistant starch is the fraction of starch that resists digestion in the stomach and small intestine but is fermented in the large intestine. Recent research has shown that resistant starch can enhance the growth of health-promoting bacteria in the intestine, improve colonic function and bowel health, lower cholesterol and plasma triglyceride, and increase the use of stored fat. Both rice cultivar and parboiling process affect the amounts of health promoting starch content in parboiled rice. Autoclaving under pressure and storage treatments promoted the formation of slowly digestible starch and resistant starch and decreased the content of rapidly digestible starch in parboiled rice. Longer autoclaving duration aids in the disorganization of starch and promotes interactions among rice components to increase slowly digestible starch and resistant starch. Therefore, it is possible to increase slowly digestible starch and resistant starch in parboiled rice by choosing rice cultivars and parboiling conditions that promote the formation of slowly digestible starch and resistant starch.

Impact

This work demonstrates that the nutritional value of rice can be enhanced through parboiling processing to increase the slowly digestible starch and resistant starch content. With current consumers becoming more health conscious, such a product will be able to provide a wider market of nutraceutical and functional foods, and benefit consumers as a useful addition to conventional prevention and treatments for a range of health conditions. The findings from this research will enhance the marketability and increase the consumption of rice products. Arkansas rice farmers will benefit as well through the diversified use of a locally available agrobiological resource.

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Arkansas Biosciences Institute; University of Arkansas
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Impact of alcohol use among adolescent and young adult romantic relationships**Issue**

Adolescence can be a period of experimenting with many drugs, especially alcohol use with approximately 39% of 8th graders, 58% of 10th graders, and 72% of 12th graders having consumed alcohol. Heavy drinking and alcohol-related problems increases during late adolescence and early adulthood. In the U.S., the highest level of alcohol consumption appears in the early twenties. Adolescence and young adulthood are also times in which dating and romantic relationships become important. Research examining selection and socialization processes in adolescence have primarily examined friendship and substance use, but not romantic relationships.

Action

Using the National Longitudinal Study (over the course of 6 years) of Adolescent Health, we examined patterns of alcohol use and found evidence to indicate that both selection and socialization effects contribute to young adults' continued drinking in romantic relationships.

Impact

A drinking young adult who is dating seems to match-up well with partners' drinking. During dating relationships there may be more perceived pressure to drink with a drinking partner out of fear of losing that partner. Once a couple is married and commitment is secured, the pressure may dissipate since similarity in drinking is no longer necessary.

When comparing dating, cohabiting, and married young adult couples, we found that young adult women and men had positive associations between partners' drinking, but this association was significantly stronger for males. That is, the more the men's female partner drank, the more he drank, more so than was found for women with their male partners.

This significant association suggests that drinking behaviors may be important when choosing a potential romantic partner, even beyond demographic similarities. In sum, young adults in romantic relationships may be exposed to social drinking that carries substantial contextual risks. Individuals who initially drink less than their partners might achieve similarity over time. Such deepening similarity may reflect a pervasive socialization influence for risky alcohol behaviors.

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University of Arkansas Division of Agriculture

A Safe and Secure Food System

Developing multiplex polymerase chain reaction for detection and identification of *Salmonella enterica* serovars

Issue

Salmonella enterica is one of the leading causes of food related illness in America, posing a serious problem in public health and food industry. Rapid and sensitive pathogen identification is required for the control of food safety. In addition, detection assay which is also able to do bacterial typing is highly desirable to determine the possible source of the outbreak. While culturing method is used as a standard for *Salmonella* detection, it needs further testing to identify the serotype of detected *Salmonella* strain.

Action

In this study, bioinformatics software was employed to design primers for multiplex polymerase chain reaction (PCR) using genes of phenotypic traits and species- or serovar-specific regions, and each primer pair was tested for its sensitivity and specificity. Based on the results from primer testing and the size of products, 6 primer pairs were selected to develop multiplex PCR. The developed multiplex PCR assay was run for 35 cycles with all 6 pairs of primers able to simultaneously detect and identify 8 different *Salmonella* serovars including Anatum, Cubana, Enteritidis, Gaminara, Infantis, Montevideo, Stanley, and Typhimurium. The developed multiplex PCR were validated with various *Salmonella* strains and non-*Salmonella* pathogens which are commonly associated with foodborne outbreaks. This multiplex PCR was able to correctly identify samples containing different serovars and did not show any cross-reactivity with non-*Salmonella* foodborne pathogens.

Impact

The developed multiplex PCR will be a simple method to correctly identify different *Salmonella* serovars with minimal cross-reactivity with other foodborne pathogens or common microflora in foods. This study demonstrated that this multiplex PCR can be a rapid and simple tool for the identification of *Salmonella* serovars present in foods or the environment. In addition, this assay can provide great potential to decrease time and cost associated with conventional serotyping methods.

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The effect of incorporating Noni (*Morinda citrifolia*) pulp or juice on the shelf-life of ground beef

Issue

Ground beef in fresh retail display oxidizes at a faster rate than whole muscle products. This oxidation causes a brown discoloration to form on the product and is discriminated by consumers. Oxidation also results in the development of detrimental off-flavors and odors. Prevention of oxidation in ground beef has the potential to lengthen the shelf-life and improve the profitability of ground beef products.

Action

The Noni plant (*Morinda citrifolia*) is grown in Southeast Asia, where it has been used as homeopathic remedy for a wide variety of diseases and ailments. In human health, Noni products have been shown to have antioxidant and immune stimulating properties. Two experiments were conducted where coarse ground beef was mixed with different concentrations of Noni pulp or juice. After 2 to 3 days of display, when ground beef typically begins to discolor, patties with higher concentrations of Noni pulp were perceived as redder and less discolored by the visual panelists. Furthermore, the instrumental evaluation of the Noni patties also found them to be redder than controls, even though all patties became less red with increasing display time. Moreover, patties with higher concentrations of Noni pulp also had lower TBARS values, indicating less lipid oxidation was occurring.

Impact

When Noni pulp was incorporated into fresh ground beef patties, this natural antioxidant was successful at decreasing lipid oxidation and improving the shelf-life and color stability. However, the objectionable off-flavors associated with this product may limit its usage in fresh ground beef in a large scale. More research needs to be conducted to improve the flavor profile of beef containing Noni pulp/juice. Perhaps other ingredients would make this combination more acceptable to panelists. It should be noted that a use-patent has been filed based on the results of these two experiments.

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Biosecurity practices and disease recognition in poultry

Issue

Mortality figures associated with broilers, turkeys, and layers continue to decrease but infectious diseases are a major cause of mortality. Avian Influenza (Bird Flu) and H1N1 (Swine Flu) were not in the news as much in 2010 as previous years; however, they are still of great concern to the Arkansas poultry industry. These concerns continue to drive the need for reinforcing educational efforts directed toward “biosecurity” to assist in preventing disease outbreaks and/or spread.

Action

Educational programs were conducted for veterinarians, poultry producers (commercial and backyard/hobby), county agents, and exotic pet bird producers about biosecurity procedures to prevent introduction of disease into their flocks, farms, or ranches. Diseases diagnosis allowed producers to initiate a course of treatment or practice to contain diseases. A timely diagnosis and treatment/control program is vital to containing a possible outbreak that could spread to numerous birds, or flocks.

Impact

The continued dialogue with numerous commercial poultry growers, backyard, hobby, and exhibition flock owners in Arkansas and other states has assisted greatly with biosecurity and an increased awareness of disease and preventative measures thus enhancing the (biosecurity) efforts of the Arkansas poultry industry.

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Impact of sanitation of deli slicers on foodborne illness

Issue

Listeria monocytogenes causes a rare but potentially fatal disease, listeriosis. The mortality rate from this disease is approximately 28%, particularly in immunocompromised individuals, who are most at risk. The economic burden for U.S. citizens for a single case of listeriosis is estimated to be \$1,659,143. The bacteria *L. monocytogenes* has been strongly linked to the consumption of deli foods and meats sliced in the deli. It has been apparent for many years that meat slicers in retail establishments can harbor large populations of bacteria and some of the pathogenic bacteria have the potential to cross contaminate sliced, ready-to-eat foods.

Action

Various methods of cleaning and sanitizing the deli slicer were evaluated as were different cleaners and sanitizers.

Impact

Dry thermal treatment at 80 °C and times of up to 15 h are not sufficient to achieve a 5-log reduction of residual *Listeria* that may have survived improper cleaning and sanitizing of the

deli slicer. However, a three-hour treatment at 80 °C produced a 2 or 3 log reduction, which would likely be adequate for a machine that had been cleaned and sanitized prior to heating. Dry thermal heating overnight could provide an extra hurdle for *Listeria* contamination in the worst case scenario of an inadequately cleaned and sanitized slicer. Barrier II, a commonly used sanitizer in delis was found to be a good sanitizer, used with a common white bar towel. Sanitation wipes, which are used in many delis to wipe slicer blades between slicing, were found to be inadequate.

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American Meat Institute Foundation and NIFA NIFSI deli food safety; University of Arkansas Division of Agriculture

Strategies to eliminate *Campylobacter* colonization in poultry

Issue

Campylobacter is 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 pre-harvest 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, and is a food-grade chemical approved by the FDA as Generally Recognized As Safe (GRAS). Published literature has demonstrated that caprylic acid is very effective in killing 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. The ability of these naturally occurring proteins to reduce *Campylobacter* in birds may provide an important tool to provide a safer food supply to consumers. Use of caprylic acid in poultry would be predicted to reduce the incidence of *Campylobacter* infections by 30 fold resulting in reduced human suffering and medical savings of tens of millions of dollars.

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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. A novel immune potentiating molecule was identified and co-inserted so that non-disease-causing safe bacteria, presenting the influenza antigens, are robustly recognized by the immune system, even after oral delivery. The resulting vaccine was shown during the last year to cause rapid immune responses which may be protective for all serotypes of Type A influenza. Previous work has indicated that this approach may provide protection, and upcoming trials in several collaborators' laboratories in the U.S. and Asia will evaluate the effectiveness of this approach for protecting commercial poultry flocks from this disease.

This technology is covered in several ongoing global patent applications and has been commercially licensed by a sponsoring company.

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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University of Arkansas Division of Agriculture

Development of novel bacterial vectored vaccines against *Salmonella* and *Campylobacter*

Issue

Salmonella and *Campylobacter* infections continue to be among 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* and *Campylobacter* infrequently cause 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 these agents prior to slaughter will not become contaminated unless processed after positive flocks. Therefore, pre-harvest 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* or *Campylobacter* serovars, this has greatly limited the effective use of vaccines under commercial conditions.

Action

With specific competitive USDA NRI funding for these projects, candidate bacterial vectored vaccine strains were developed which express a conserved flagellar antigen sequence from *Salmonella* and *Campylobacter* on the bacterial cell surface. These antigens share extensive homology with many *Salmonella* serovars as well as *Shigella* and *E. Coli*. The current bacterial vector consists of a harmless (Generally Recognized As Safe) organism expressing *Salmonella* and *Campylobacter* antigens, along with an immune enhancing molecule that

causes this vector to be recognized by the immune system, even when administered orally. These candidate vaccine strains have been used in experimental studies to determine serum antibody titers to the cell surface expressed antigen, and results indicate that vaccinated birds are highly resistant to infection.

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.

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Development of a direct fed microbial for replacement of growth promoting antibiotics and improved food safety

Issue

Antibiotic usage in animal agriculture is under continuing pressure from consumers and regulatory agencies. Previous work within the Center of Excellence for Poultry Science has shown that certain formulations of beneficial bacteria could protect commercial poultry from infection with a variety of enteric bacterial pathogens, with comparable results to antibiotic use in several published trials. However, until recently, the most effective cultures have been non-spore former probiotics that were not suitably stable for inclusion in poultry feeds, requiring administration in the drinking water. For a number of reasons, feed application is preferred by much of the poultry industry.

Action

After several years of USDA-sponsored research, a combination of Generally Recognized As Safe (GRAS) spore-forming Bacilli have been isolated which reduce infection with *Salmonella* and with the agent causing Necrotic Enteritis (*Clostridium perfringens*) in poultry, a limiting disease for poultry raised without antibiotics. Further, a high yield method of amplification of spores for cost-effective commercial production was developed. Testing has shown that these spores withstand commercial feed pelleting and are completely stable when incorporated into poultry feed.

Impact

In late 2010 the resulting product, under license from the University of Arkansas, was commercially launched in the U.S. under the trade name Sporulin®. The University of Arkansas licensee has plans to launch this product globally in 2011.

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Electrostatic spray treatments with malic/lactic acid in combination with grape seed extract is effective in disintegrating biofilms and decontaminating pathogens in spinach and lettuce

Issue

Fresh produce has been emerging as one of the major vehicles of foodborne pathogens. *Salmonella* Typhimurium and *Escherichia coli* O157:H7 are two of the most significant pathogens implicated in several foodborne outbreaks increasingly associated with fresh produce. Adhesion and internalization of pathogens in fresh produce have limited the potential of conventional disinfection strategies. Moreover, these current techniques with chemicals and other modes of sanitizing result in no more than 2 log reductions of the pathogens in produce. Such traditional methods do not distribute the disinfectant evenly or cover the entire produce surface. The pathogens in the untreated niches and biofilms can survive and cause foodborne illness. Fresh produce are minimally processed and do not have a treatment or killing step before consumption by people for their health benefits. Thus safety and security of fresh produce is critical for preventing/minimizing recalls owing to pathogen contamination.

Action

Organic acids (malic, lactic and tartaric acids) and natural plant extracts (grape seed and green tea extracts) were tested for their effectiveness as antimicrobials on spinach and iceberg lettuce. The mode of application of antimicrobials onto the produce was also compared using electrostatic and conventional spraying. The effective concentrations of antimicrobials (malic and lactic acids, grape seed extract) for electrostatic spraying were optimized using response surface method.

Impact

Electrostatic spraying of malic and lactic acids and grape seed extract can effectively inhibit *S. Typhimurium* and *E. coli* O157:H7 on spinach and iceberg lettuce in comparison to conventional spraying due to uniform deposition of antimicrobials on the surface and greater retention of antimicrobials. 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 without compromising food quality (color and texture). These natural antimicrobials can function as alternatives to chemical disinfectants in processing stages and help obtain a higher inhibition of pathogens. This can serve as a potential multiple-hurdle-technology to disrupt the biofilms formed by the foodborne pathogens and decontaminate fresh produce.

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Natural green tea and grape seed extracts can partially replace chemical preservatives used in commercial hotdog formulations**Issue**

Despite several efforts and strategies in reducing the contamination of food products, foodborne illness remains a major concern to the food production industry as well as the consumers. In the U.S., 76 million cases of foodborne diseases with 325,000 hospitalizations and 5,000 deaths occur each year. Outbreaks of foodborne pathogens including *Listeria monocytogenes* (*L.m*) contaminated ready-to-eat (RTE) such as deli meats and hotdogs posed the highest per serving risk of illness/death. Furthermore, there is an increasing demand of the consumers to use more natural and fewer chemical/synthetic preservatives to inhibit the foodborne pathogens.

Action

A study was conducted initially to determine the optimum concentrations of green tea extract (GTE) and grape seed extract (GSE) in low fat chicken hotdog model system. In this study 15 treatments of low fat chicken hotdogs including various combination levels of GTE and GSE (0%, 1%, and 2%) were formulated and used to determine the antimicrobial properties against *L.m*. Optimal concentrations of GTE and GSE thus determined (1.4% and 0.9% respectively) were used in a study with varying combinations of chemical antimicrobials [Sodium Diacetate, SDA (0.15% or 0.20%) and Potassium Lactate, PL (2.8% or 3.0%)] in low and high fat chicken and turkey hotdogs to determine the best combination of chemicals and plant extracts against growth of *L.m*. All the treatments (hotdog slices; 1 cm³, 1-1.5 g) were surface inoculated with *Listeria monocytogenes* bacterial suspension (10⁴ CFU/g), vacuum packed and stored at 4 °C over 28 days.

Impact

This study suggested that chemical preservatives used in hotdogs can be partially replaced by natural plant extracts. Reducing conventional chemical antimicrobials and incorporating natural “green” plant extracts will provide the processing industry with a consumer attractive and preferred alternative of using natural sources of antimicrobials that are effective and inexpensive. Further research is needed to investigate the effect of the chemical preservatives-plant extract combinations along with heat treatment for further improving the inhibition of these foodborne pathogens.

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Marinating irradiated boneless/skinless chicken breast meat in tartaric acid and grape seed and green tea extracts not only inhibits *Listeria monocytogenes* growth but also prevents lipid oxidation**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. These off-flavor products are not acceptable to consumers. There is a need to investigate strategies to overcome this problem.

Action

Tartaric acid (TA) and a combination of grape seed (GSE) and green tea extracts (GTE) were incorporated into boneless/skinless chicken breast meat via vacuum-tumble marination. The marinated samples were irradiated using electron beam at 0, 1.0, 2.0 and 3 kGy. These products 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 of incorporation of tartaric acid and grape seed and green tea extracts on consumer acceptance of marinated irradiated and non-irradiated chicken breast meat.

The results showed that samples vacuum-infused with TA at 37.5 and 75.0 mM and irradiated at a low level of 1 kGy significantly reduced *Listeria monocytogenes* (*L.m.*) levels by 2 and 3 log CFU/g compared to the control after 12 d of refrigerated storage. Vacuum-infusion of TA at 37.5 and 75.0 mM at 2 and 3 kGy irradiation, reduced *L.m.* to near nondetectable levels. The addition of tartaric acid and natural plant extracts to chicken marinades could contribute to the prevention of *L.m.* contamination, and has the potential to reduce the effects of irradiation on meat quality and shelf life.

Impact

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 does not significantly alter the texture, pH, or WHC of the chicken meat. The addition of TA and GSE and GTE to chicken breast fillets with and without irradiation did not significantly impact consumer preference, tenderness, appearance, or flavor. The findings of this investigation demonstrate the effectiveness of multiple hurdle technologies to effectively control the overall quality of the processed chicken and will be valuable to a processor.

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Nanoparticle-mediated delivery of phenolic compounds to combat foodborne pathogens in broth and chicken meat

Issue

Listeria monocytogenes, *Escherichia coli* O157:H7 and *Salmonella Typhimurium* are foodborne pathogens of immense importance in the food industry, associated with a number of recurring food recalls and food-related illness outbreaks. The foodborne illnesses caused by such pathogens pose an enormous social and economic burden in the nation amounting to over \$152 billion annually with an increasing number of recalls and outbreaks, and losses associated with every major food contamination issue, more research is being directed towards finding measures to mitigate the present problem. In addition to this, there is an increasing demand for the adoption of natural and alternative ways to disinfect food products. Several disinfection strategies are in place to control pathogens but there is a need for a system that interacts less with the food, helps deliver an antimicrobial in a better way and helps sustain the antimicrobial activity over a longer period of time.

Action

Phenolic compounds are naturally occurring secondary metabolites in plants secreted as defense agents. Our aim was to employ an effective natural antimicrobial along with a proper and novel delivery method to better control foodborne pathogens. Previous studies with phenolic compounds and pathogens (*Listeria monocytogenes*, *S. Typhimurium* and *E. coli* O157:H7) in brain heart infusion (BHI) medium showed that gentisic, benzoic and vanillic acids were effective alone and in combinations against the pathogens. The antimicrobial activities of phenolic compounds with and without nisin and ethylenediamine tetraacetic acid (EDTA) were also tested in broth cultures. Furthermore, the packaging of the phenolic compounds with and without EDTA into polyglycolic acid-lactic acid nanoparticles was investigated for enhancement of the antimicrobial activities against each pathogen in meat system.

Impact

Our solution to the problem not only lies in finding a natural antimicrobial or a combination of such antimicrobials that can decontaminate the food but also in using a proper delivery system that can improve the inhibition of the pathogens with little interaction with the food matrix, as a multiple hurdle technology. The phenolic compounds (benzoic, gentisic and vanillic acids) used in the study are those naturally occurring in plants and hence will act as safer alternatives to the use of harsh disinfectants. Nanoparticle-mediated delivery of phenolic compounds can serve as a novel and promising multiple hurdle technology to combat foodborne pathogens. Our current findings on the efficacy of phenolics delivered by nanoparticles in a meat system indicated the potential of both the phenolic compound and the delivery system to be effective when encountering issues with pathogen contamination.

This can help ensure safety of the food product until it reaches the consumers, decrease economic losses associated with food recalls and the financial burden of the public afflicted by the pathogens.

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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 in more than 46 countries for animal cases and in 15 countries for human cases with 467 people infected and 282 dead 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 flow-through 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 EID₅₀/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 any in-field AI test instrument available, this biosensor would provide the poultry industry with a much 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 animals and humans.

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Funding

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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, enzyme-linked immunosorbent assay (ELISA) and polymerase chain reaction (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 highly efficient separation of the foodborne and waterborne pathogens, including *E. coli* O157:H7, *S. Typhimurium*, and *L. monocytogenes*. The key tasks were accomplished, and they are (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 magnetic 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 that have 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 was removed from the mixture.

Impact

The results of this project could provide the food industry with new technology to prepare the food samples for rapid detection of food-borne 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 coupled 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 food-borne sickness and associated medical costs. This technology will also help our society reduce food-borne diseases and strengthen the safety and security of our food supply system.

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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 dead 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 the 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 surface plasmon resonance (SPR), impedance or magnetoelastic biosensor. H5N1-bound DNA aptamers were selected by incubating H5N1 virus with a DNA library of about 10^{14} molecules randomized at central 74 nt and subsequent nitrocellulose filtration. Aptamers were eluted from filters and amplified by polymerase chain reaction (PCR). Single-stranded aptamer DNAs were derived from this double-stranded DNA stock by asymmetric PCR as input for the next selection cycle. Individual aptamer DNAs were 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 aptamer 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 monitor avian influenza H5N1, different subtypes and other poultry diseases with lower testing cost.

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CitriLow reduces bacteria in ground beef

Issue

The processes involved in ground beef production systems, such as mixing and grinding of raw materials from different animals, may transfer various microorganisms to final ground beef products. A California based firm in August, 2010 recalled approximately 1 million pounds of ground beef products due to possible *E. coli* O157:H7 contamination (FSIS-RC-048-2010). There is a great need to find efficient decontamination techniques to enhance ground beef microbial quality. A novel cost-effective hydrochloric/citric acid (CitriLow™) blend is a generally recognized as a safe (GRAS) antimicrobial which sustains the pH range that is most effective in controlling pathogenic bacteria. Even though this acid mix has been approved to use in beef, its use as a pre-grinding treatment on beef trimmings to reduce pathogenic bacterial load in ground beef products is yet to be investigated.

Action

Inoculated beef trimmings (*E. coli* and *S. Typhimurium*; 10^7 CFU/ml) were vacuum tumbled with individual antimicrobial treatment of 15% hydrochloric/citric acid blend (CIT) or CIT followed by 4% sodium metasilicate (NMS), 0.4% cetylpyridinium chloride (CPC), 10% trisodium phosphate (TSP) or Water (W). The treated and untreated control beef trimmings were ground twice and 250g ground beef samples were placed on plastic foam trays with absorbent pads and over wrapped with polyvinyl chloride film. All ground beef packages were stored under simulated retail conditions and sampled on day 1, 2, 3, 4 and 7 for microbiological and instrumental color evaluations.

Impact

The use of a hydrochloric/citric acid blend (CitriLow) in single or multiple decontamination intervention with water, CPC, NMS or TSP on inoculated beef trimmings significantly reduced the microbial populations in subsequent ground beef. The results indicated that although CitriLow alone, followed by water or CPC achieved a higher microbial count reduction, CitriLow followed by NMS and TSP provided the additional benefit of retaining ground beef color properties up to 7 days of display. Therefore, a hydrochloric/citric acid blend along with NMS and TSP application may provide successful decontamination application while maintaining the ground beef color properties. However, detailed studies on the impact of these treatments on organoleptic properties of ground beef under un-inoculated conditions are recommended.

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Decontamination of meat can help reduce human foodborne infections

Issue

Survival or growth of potentially life threatening microbial pathogens in the food supply is a major public health issue. The beef industry is continuously challenged by product recalls resulting from contamination of ground beef and ground beef products with *Salmonella* spp. and *Escherichia coli* O157:H7. Currently, there is a great need for decontamination technologies that effectively control meatborne pathogens on trimmings while providing acceptable quality in finished ground beef.

Action

The impact of antimicrobial interventions on ground beef produced from treated beef trimmings was evaluated in two studies. Beef trimmings were inoculated with a mixture (7 log CFU/ml each) of *Escherichia coli* (EC) and *Salmonella* Typhimurium (ST). In one study, trimmings were treated with either: (1) 2% malic acid (MA); (2) 0.4% Cetylpyridium Chloride (CPC); (3) 200 ppm peracetic acid (PA); (4) 400 ppm octanoic acid (OA); (5) inoculated untreated control (IN); or (6) uninoculated untreated control (C). In the second study, trimmings were treated with either (1) 2% malic acid (MA); (2) 3% potassium lactate (KL); (3) 200 ppm peroxyacetic acid (PA); (4) 400 ppm octanoic acid (OA); (5) inoculated untreated control (IN); or (6) uninoculated untreated control (C).

Following antimicrobial treatment, trimmings were subsequently treated with 10% TSP and ultra-chilled with solid carbon dioxide for 30 seconds. Trimmings were ground and packaged on styrofoam trays with absorbent pads, overwrapped with polyvinyl chloride film, and sampled for EC, ST, coliforms (CO), aerobic plate count (APC) on days 1, 2, 3, 5, and 7 of display.

Impact

Results indicated that all treatments effectively reduced CO, EC, APC, and ST counts compared to the inoculated control on days 1, 2, and 3 of display. The ultra-chilling of the trimmings showed no microbial reduction compared to the inoculated control but improved the product retail display quality characteristics during display days (1, 2, 3, 5, and 7). Results from these research projects suggest that meat processors can design effective decontamination strategies to ensure the microbial safety of ground beef.

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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. It is estimated that in the U.S., *Salmonella* causes more than 1.3 million persons to become ill, 553 deaths and economic losses of \$2.4 billion annually. A total of 5,000 foodborne illness outbreaks with a known etiology and vehicle occurred from 1990-2004. Raw chicken and chicken products were linked to 214 outbreaks of foodborne illness and of these, 195 were caused by *Salmonella*. 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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An integrated systems approach to reduce *Salmonella* in organic and all 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-scale 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 that 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 and 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 their 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, 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

Campylobacter detection and evaluation studies

Issue

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 a long period of time outside the host. Yet this organism is capable of surviving adverse conditions and causes disease in humans. Adhesion and invasion are thought to be important factors for the colonization of *C. jejuni* in the intestinal tract of hosts. We investigated the adhesion and invasion abilities of the organism after stress-adaptation to stresses such as acid and starvation. The experiment was repeated with different isolates and different times of exposure to stress. In this study, INT 407 cells which originated from human jejunum and ileum were used as the in vitro model for *C. jejuni* attachment and penetration studies. When non-stressed strains of *C. jejuni* were exposed to acid stress with hydrochloric acid, one of the strains from pre-processing chicken carcasses showed reduced adhesion and invasion. But cells of this strain showed an adaptive tolerance response to acid after 2 h exposure to a sub-lethal pH was found to increase adhesion and invasion of acid-adapted cells to further acid stress. For the human isolate of *C. jejuni*, ATCC 81-176, invasion was found to be greater for non-stressed cells than the stress-adapted cells, whereas no change was observed in adhesion. Two other strains, one from post-processing chicken carcasses and one from retail chicken carcasses, did not show any significant difference in the adhesion and invasion between the stress-adapted and non-stressed cells. No significant difference was observed in adhesion and invasion when acid-adapted cells were exposed to stress with lactic acid or when exposed to starvation stress.

The experiments were repeated with a different acid stress adaptation of 3 h. With this adaptation period, the isolate from

the retail chicken carcass was found to possess an adaptive tolerance response which helped the isolate in increased adhesion to and invasion of epithelial cells. All the other three isolates used did not show any significant differences between the acid-adapted and non acid-adapted organisms. These 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.

We also looked into the effect of the quorum sensing on the stress- adaptation of *C. jejuni*. A *luxS* mutant strain of the human isolate 81176 was used for these experiments. Both the *luxS* mutant strain and the 81176 strain were subjected to acid-adaptation by exposing them to a sub lethal pH of 5.5 for 2 h. The strains were then exposed to a lethal pH of 4.5. Cultures of *C. jejuni* in *Campylobacter* enrichment broth formed the control groups which were subjected to direct acid stress by suspending them in a lethal pH of 4.5. No significant differences were observed in the viability of the organisms between the control groups and the acid-adapted groups. These results indicate that the *luxS* gene controlled autoinducers production may not be having an effect on the acid adaptation of the organism.

We also investigated the effect of antibiotics on the stress-adaptation of *C. jejuni*. Four different isolates were subjected to acid stress for a period of 2 h or starvation stress for a period of 24 h which formed the acid-adapted and starvation-adapted groups and cultures of *C. jejuni* subjected to no acid stress formed the control groups. Both the acid adapted group and their control group were then subjected to further acid stress and incubated for 100 min either in microaerobic or aerobic atmospheres. The starvation-adapted group and their control group were subjected to further starvation stress for 24 h. No significant differences were observed between the stress-adapted and non-stress adapted organisms.

Impact

These studies indicate that stress adaptation may not influence the resistance or sensitivity of *C. jejuni* towards antibiotics. Work is in progress to determine other virulence genes and genes involved in stress adaptation as well to identify the proteins that they encode.

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Funding

USDA/CREES; University of Arkansas Division of Agriculture

Assessment of preparedness for agricultural bioterrorism in Arkansas

Issue

Agricultural bioterrorism is one of the important issues that emerged after the terrorist attacks of September 11, 2001 and subsequent anthrax related threats in the United States. The use of biological weapons to cause destruction of agriculture and agriculture related industries in various ways has

become a menacing possibility. Any potential agroterrorism event can have local, national and international repercussions for producers, consumers, and the food and feed processing and distribution system. The Arkansas grain, feed and oilseeds industry is very important economically both in terms of domestic use and international exports.

The Agriculture Bioterrorism Protection Act of 2002 deals with the protection of U.S. agriculture. Under the Act, the Food and Drug Administration is charged with regulation of the grain and oilseed industry. Specifically, the domestic and foreign facilities (and their U.S. agents) that “manufacture, process, pack or hold for human or animal consumption in the U.S.” were to be registered with the FDA on Oct. 10, 2003. Facility registration is required for grain elevators, feed mills, flour mills, corn and oilseed processors, pet food manufacturers, renderers and others. Facilities also need to establish and maintain records containing information that is “reasonably available” to identify immediate previous source, immediate subsequent recipient, dates of inbound and outbound shipments, type and quantity of agricultural commodity received and shipped, identity and contact information of the transporter.

Action

To assess the preparedness of Arkansas grain, feed and oilseed facilities for agricultural bioterrorism, a questionnaire was sent out to all Arkansas grain and feed elevators and processors as well as seed and feed dealers. The survey was mailed to the grain and oilseed facilities in the state of Arkansas in July 2010 and 48 facilities responded to the survey. Information on facility type, size and history of vandalism, unauthorized entry, intentional contamination, sabotage, theft or threats was obtained. Information on testing procedures and plant security were also obtained. The study also assessed whether changes to preparedness had been made following the enactment and implementation of the Agriculture Bioterrorism Protection Act of 2002.

Impact

The Arkansas grain and oilseed industry and government agricultural bioterrorism regulators will be helped by the in-

formation reported from this survey. This assessment provides a useful evaluation of the readiness of the Arkansas grain and oilseed industry to address risks associated with agricultural bioterrorism. The study found that record-keeping systems that track commodities were in place in 71% of facilities before 2002 and 17% added systems after 2002. Over two-thirds of the facilities do not have quarantine procedures. Soybean processors and rice mills were most likely to have those procedures in place. Employee training for security and disaster-specific employee training were added by 19% of facilities after 2002. Currently 93% have employees trained to report suspicious activity. Computer and on-line security was added by 21% and a formal agreement with first responders was added by 14% since 2002. Still, about half of the facilities have no computer security measures, disaster training or first responder agreements. The study will be presented at the 2011 SAEA annual meeting as a selected paper. All Arkansas grain, feed and oilseed facilities and relevant government agencies will be sent copies of the report.

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NC-1016 Multi-state Research Project, Economic Assessment of Changes in Trade Arrangements, Bioterrorism Threats and Renewable Fuels Requirements on the U.S. Grain and Oilseed Sector

Funding

Arkansas Agricultural Experiment Station, University of Arkansas Division of Agriculture

Greater Harmony Between Agriculture and the Environment

An ammonia emission mitigation system for commercial broiler houses

Issue

Air quality impacts from confined animal feeding operations (CAFO) is an emerging issue. Potential regulations could affect the economic viability of animal agriculture all over the U.S. As a top poultry state, and home to several poultry integrators, there is an opportunity for Arkansas to become a benchmark state for conducting research on air quality issues from poultry operations. 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 two-component 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 a biofilter and also testing it with various filter media at laboratory scale. 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 been 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.

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Funding

USDA-NRI; University of Arkansas Division of Agriculture

Application of cotton gin waste and recycled cotton bale wrap in ligno-cellulosic 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

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

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. 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 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

Distillers dried grains with solubles fiber filled thermoplastic composites

Issue

Distillers dried grains with solubles (DDGS), a co-product of ethanol production, is used as poultry feed after processing to remove excess fiber. This project explores the use of DDGS fibers in thermoplastic composites as filler for thermal and dimensional stability.

Action

To evaluate DDGS fiber as a filler in thermoplastic composites, an experiment was conducted with different proportions of wood and DDGS in the composite matrix. The different fiber proportions included (a) 100% oak, (b) 25% DDGS + 75% oak, (c) 50% DDGS+50% oak, and (e) 75% DDGS+25% oak. All samples were replicated 3 times and the samples were run as a completely randomized block design. The samples were extruded and currently are being tested for physical and mechanical properties.

Impact

If the properties of the composite made with DDGS fiber are found to be comparable to the commercially available wood plastic composites, it will open another avenue for inexpensive raw material for the composite industry while generating value for DDGS and extra income for the farmers.

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Funding

University of Arkansas Division of Agriculture

Remote sensing technology for quantifying stream bank erosion

Issue

New methods are needed to evaluate the effects on water quality of anthropogenic factors such as urbanization and agriculture, and natural processes such as soil erosion, among other things. 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 cover changes in the last 20 years using remote sensing. Currently, we are analyzing the impact of change in 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.

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Funding

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

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 animal, are arthropods (insects, spiders, mites, crustaceans, and related groups). Insects account for over half of all species described. More than 35,000 species of arthropods have been recorded from Arkansas, and new and unnamed species are found in the state. Because of the diverse ways that arthropods affect humans, it is important to know what species occur and be able to name them. Knowing the name of an arthropod is the key to unlocking the store of accumulated knowledge about its life history, distribution, and relationships to humans. Most arthropods are not easily identified to species level – even by insect taxonomy specialists. The University of Arkansas Arthropod Museum is the largest research and reference collection of insects and other arthropods in the state of Arkansas. The museum holds one of few large collections of the insects of the species-rich and unique Ozark Plateau and Ouachita Highlands.

Action

The museum's collection has new specimens added each year to increase its representation of the Arkansas fauna. New specimens of arthropods are identified using specialized techniques, equipment, and literature; as they are identified, they become references for comparison with further new specimens. The curator provides identification and information services to extension personnel, researchers, and the general public. Specimens are loaned to interested researchers around

the world. Auxiliary collections are maintained for demonstration and teaching purposes. The museum's website assists the extension, research, and education missions.

Museum staff continue to rearrange the collection to aid in locating specimens of a given species. Another 9000 specimens stored in alcohol have been transferred to more secure vials. In 2010, eleven new articles were added to the *University of Arkansas Arthropod Note* series on the museum's website <www.uark.edu/depts/entomolo/museum/museum.html>: golden digger wasp, elm sawfly, glow-worm, red imported fire ant, pinching bug, Pennsylvania leatherwing, southern armyworm, nine-spotted lady beetle, chiggers, azalea lace bug, confused flour beetle (Arthropod Notes 69–79). The 79 articles in the series receive wide notice and praise.

Impact

The museum's collection serves as the major reference resource for arthropod identifications in Arkansas. The hundreds of identifications we provide help researchers, government agencies, businesses, and the public, who need identifications to make pest management decisions. The museum is listed the recent compilation of world insect collections, and researchers worldwide use the collection for taxonomic research. Each year, museum specimens are displayed at various venues, giving upwards of 15,000 citizens some exposure to the world of insects.

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University of Arkansas Division of Agriculture

North American robber flies as insects of conservation concern

Issue

Robber flies comprise one of the most diverse, abundant, and conspicuous families of flies worldwide. More than one thousand species are known from North America. Because of their affiliation with specific habitats, robber flies are important as indicators of environmental health.

Action

The continuing survey of robber flies in Arkansas has resulted in a checklist of 131 species, of which 66 species were recorded for the first time from the state. Analysis has shown that robber flies of Arkansas have close affinities with the fauna of the eastern United States. Research on robber flies has added to the knowledge of this family, including the description of rare new species, known only from the endangered blackland prairies of Hempstead County, Arkansas.

Impact

Robber flies are significant elements of the ecosystem. They are excellent candidates for use in ecological monitoring. Along with butterflies, tiger beetles, and dragonflies, robber flies are receiving increased levels of interest as a focus of conservation concern, particularly as habitat loss has contributed to population declines among some species of robber flies.

Species found in grasslands, such as remnant prairies, indicate the uniqueness and importance of those habitats. Studies of robber flies can help provide land managers and the conservation community with indicators of habitat quality and change, and assist in making management decisions.

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Funding

University of Arkansas Division of Agriculture

Water and sediment quality of agriculturally dominated ecosystems

Issue

As agriculture output increases to provide food and fiber for a growing global population, water quality issues threaten the supply of fresh water. Global sustainability is linked to fresh water supplies to supplement crop production and provide habitat for fisheries and natural aquatic ecosystems that provide resources to our society. Fresh water supplies are limited, and impaired drinking water supplies increase treatment costs for potable public water. Protection of fresh water resources and prevention of degraded water supplies can be accomplished with proper management practices of point source discharges (e.g., municipal/industrial outfalls) and nonpoint sources (agricultural/construction runoff). Sediment from disturbed sites contaminates surface water runoff into fresh water ecosystems. Sediment is cited as the primary cause of nonpoint source pollution and often carries additional contaminants (i.e., pesticides, nutrients, and pathogens).

Action

Numerous studies are being conducted to determine the effect of various agricultural practices and measure efficiency of management practices intended to minimize nonpoint pollution. In the Upper Strawberry River Watershed, the effectiveness of best management practices (BMPs) on grazing and hay production fields is measured. Practices include fencing from stream, alternate watering sources, and subsurface nutrient application. Total suspended solids (TSS), nutrients, *E. coli*, stream bank stability, benthic macroinvertebrates, and aqueous and sediment toxicity are measured in this watershed. Impacts from row-crop agricultural practices are studied on established bioenergy plots with locally available soil amendments on the Arkansas State University Farm Complex. Concurrent with water quality impacts, earthworm avoidance tests are used to measure soil quality of alternative organic fertilizers. Water and sediment quality are measured from cotton production fields at Judd Hill Plantation to gauge effectiveness of BMPs on field test plots. Aqueous and sediment toxicity testing, TSS, and nutrients are measured to determine water quality from conventional till, no till and no till with cover crops at this study site.

Impact

Results from these studies will determine the efficacy of various management practices and their capacity for protection of fresh water resources. Best management practices

must be tailored to each ecosystem and agricultural practice. Unique soils, hydrology and agricultural activities within each watershed will determine the management and conservation practices best suited for the system. Measuring the water quality from these diverse systems will provide alternatives to the agricultural community and protect the agriculturally based economy in Arkansas. These decisions are intended to maximize yields while protecting the limited fresh water resources of our state.

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Funding

U.S. Department of Energy Project # DE-FG36-08BO8803; Arkansas Natural Resource Commission 319 grant; USGS 104B grant through the Arkansas Water Resources Center; Cotton, Inc.; University of Arkansas Division of Agriculture

Wastewater treatment plant effluent effects on White River water quality and nutrient retention and transport

Issue

Wastewater treatment plays a crucial role in preserving water quality in receiving streams; however, continuous nutrient enrichment affects a river's ability to uptake and transform nutrients. Beaver Lake is the primary source of drinking water for the majority of northwest Arkansas residents. The intake for Beaver Water District, the largest drinking water treatment plant on the lake, is approximately 20 river miles from Fayetteville's east-side wastewater treatment plant (WWTP) effluent discharge location into the White River. Considering that the White River is classified by the Arkansas Department of Environmental Quality as a degraded waterbody due to siltation/turbidity limitations on aquatic life, nutrient enrichment, particularly N and P additions, to the river from the effluent discharge may also be contributing to eutrophication in the lake through increased biomass production. Knowing the interactions that these nutrients have once discharged into the White River ecosystem is important to understanding the fate and retention of N and P in the river and can lead to management solutions to protect water quality in Beaver Lake.

Action

The longitudinal gradient in nutrient concentrations downstream from a WWTP effluent discharge can be used to evaluate nutrient retention and more specifically the net nutrient uptake length. Nutrient retention can be analyzed by comparing the input nutrient load to output nutrient load of a study reach. Thus, a two-year study (2006-2007) was conducted along a 6.1-km reach of the White River, where the fate and transport of added nutrients was examined by analyzing and comparing nutrient load inputs to outputs and by using the nutrient spiraling framework for calculating net nutrient

uptake lengths. Water quality parameters were measured approximately monthly at one up-stream and five down-stream locations from the WWTP effluent discharge.

Impact

The WWTP effluent discharge increased stream nitrite, soluble reactive phosphorus, and total organic carbon concentrations as well as conductivity. Increasing river discharge raised dissolved oxygen concentrations and turbidity, but lowered temperature, conductivity, and total organic carbon concentrations. Significant interactions between site location and river discharge were observed with nitrate, total nitrogen, total phosphorus, and chloride concentrations. Net nutrient uptake lengths were inconsistent for nitrate, ammonium, or soluble reactive phosphorus. Interpretations for nitrate and soluble reactive phosphorus suggested that the fluvial channel acted as both a sink and a source of nutrients, but the channel always acted as a sink for ammonium. When retention of nutrients was analyzed by the whole-study-reach approach, only the mean ammonium retention coefficient was numerically different from zero suggesting that only 12% of added ammonium was retained in the study reach. The effluent discharge increased the concentrations of several water quality parameters, and it appears the long-term enrichment has rendered the immediate-downstream reach ineffective as a nutrient sink. Nutrients added in the WWTP discharge were transported downstream with little to no uptake or transformation before reaching Beaver Lake.

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Funding

Beaver Water District; University of Arkansas Division of Agriculture

Producing sugar streams with minimal inhibitor concentration from herbaceous and woody feedstock

Issue

In the biochemical conversion platform, the production of bio-based products implies the release of cellulose and hemicellulose from the feedstock cell wall by a combination of pretreatment and enzymatic steps. Improved production of sugar streams from herbaceous and woody feedstock that have minimal five and six carbon sugar-derived inhibition products will enhance the enzymatic hydrolysis step and the fermentation step. The tested feedstocks are switchgrass, poplar and sweetgum.

Action

This research program is focused on understanding how the hemicellulose breaks down to single sugars, without the production of inhibition products. Unfortunately, hemicel-

lulose 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, formic acid and acetic acid which inhibit the enzymatic hydrolysis step. We are working at determining processing conditions that minimize the production of furfural, formic acid and acetic acid.

Impact

Delineating the formation of furfural, formic acid and acetic acid during pretreatment so that processing conditions that minimize their production can be determined will help ensure that cellulosic feedstocks are used in an optimal fashion.

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

Promoting consumer horticulture in Arkansas

Issue

Home gardening is a growing activity in Arkansas and generates volumes of calls in county offices statewide. Arkansas has had a strong volunteer presence in the Master Gardener program and it continues to grow and strengthen. In addition, statewide public gardening events are on the rise. While we feel that extension programs are well known throughout the state there is always room for improvement. It is also important that university based information is readily available to all Arkansans in a quality package.

Action

To help ensure that materials used by county agents and Master Gardeners are of the highest quality, we have conducted numerous classes on PowerPoint, graphic design and digital photography across the state. These materials are then posted on the ftp site for all counties to use. In addition, a garden calendar was designed and printed by the Master Gardener program. These for-sale publications are being used not only as a fundraiser, but also as a marketing tool. A photo contest was held statewide to choose the pictures for the calendar. Ten gardening tips per month are posted in the calendar and there is a listing of all county offices. We provided five free copies to each county office to use with their local leadership and made the calendars available to people statewide. The home and garden section of the extension website is the most popular site. In addition we started an Arkansas Master Gardener Facebook account and a garden blog. New display boards were designed and are available for use at fairs and trade shows statewide. An interactive gardening display was conducted at the 2010 Arkansas Flower & Garden Show.

Impact

County Agents and Master Gardeners statewide have had easy access to quality PowerPoint programs that they have

used in county programming. Over 1500 gardening calendars have gone out statewide. The display at the Arkansas Flower & Garden Show was one of the most popular sites at the show generating hundreds of questions on raised bed vegetable gardening, rain barrels and gardening in general. The “In the Garden” blog had over 22,000 readers just since May alone. With good communication we have seen events fill up quickly. Our state conference was full with 420 attendees and a waiting list to get in. The Master Gardener Study trip to Costa Rica filled up in less than two weeks of being announced.

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Funding

University of Arkansas Division of Agriculture;
University of Arkansas Master Gardener Program

Master gardener leadership training

Issue

The Master Gardener program continues to be a strong and vital program in Arkansas with continued interest in becoming a volunteer. Many counties are beginning to struggle to get volunteers to step up into a leadership role. Another concern is that as the program continues to grow—62 county based programs and 3000 volunteers—management issues arise.

Action

The state Master Gardener advisory board has a committee whose mission is to plan and implement leadership training. To encourage better participation statewide, funds were raised at the state Master Gardener convention earmarked for leadership. We were able to pay the registration fee for two Master Gardeners per county. We had over 100 in attendance at the two day event which was held at the Winthrop Rockefeller Institute.

Impact

Several counties have implemented changes in their programs and have developed tools to use in recruiting new Master Gardeners as well as leaders. Due to the successful program we have also seen a rise in membership in our state advisory board. A statewide Facebook account was begun to help share information. A garden blog has also had a strong following. Not only did this event build the Master Gardener program in each county, but the Master Gardener volunteers who organized the event built strong tools for their own leadership abilities.

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Funding

State Master Gardener Convention; University of Arkansas Division of Agriculture

Biodiversity of soil and litter inhabiting mites in Ozark forests

Issue

Mites are the second-most-diverse groups of arthropods on the planet, but relatively little is known about their biology and diversity. Almost nothing is known about the occurrence, abundance, and identity of mites that inhabit soil and litter in the Ozarks. Further, very little information is available regarding the role these mites play in nutrient cycling and decomposition, pest and disease causation or mitigation, and relationships between mite diversity and optimal soil conditions for agricultural production. Knowledge of how mites affect soils, is necessary for developing successful management practices.

Action

We sampled soil mites present in Ozark forest habitats in Arkansas and Missouri, making collections in large, healthy forests in Buffalo National River, Devil's Den State Park, Ozark-St. Francis National Forest, and Mark Twain National Forest. We gathered soil and decomposing matter on the soil, extracted all living arthropods from samples, and then sorted them into different groups. Collection began in the spring and ran throughout the summer. Mites sorted from the samples are being identified, and work to date suggests numerous new species will be described. Additional sampling of all desired habitats will occur from April to September 2011.

Impact

This study will establish an extensive reference collection of Ozark soil- and litter-inhabiting mites and provide a critical resource for future studies of soil mites. The study will allow us to document the abundance and species diversity of mites in Ozark forests. The results may also allow us to compare the numerous mite groups found in the system and identify patterns and correlations between forest type and the mite communities present. Finally, this study will lay the foundation for future studies to determine the role of mites in soil systems and their impact on soil health and regeneration.

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Funding

University of Arkansas Division of Agriculture

Performance and physical properties of biocontainers used in greenhouse and nursery crops production

Issue

Greenhouse and containerized nursery crops are grown in containers typically made from petroleum-based plastics. However, the extensive use of plastic containers has resulted in waste disposal problems. As the greenhouse and nursery industries become more focused on increasing the sustainability of their operations, the amount of waste plastics generated has become an issue. Although recycling of containers is an option in some situations, reducing the use of plastic containers

by increasing the use of biocontainers is a strategy that could reduce the amount of waste plastic generated by greenhouses and nurseries.

Action

The physical properties of water use, strength, algal/fungal growth and decomposition were evaluated for ten types of biocontainers compared to traditional petroleum-based plastic containers. Physical properties varied significantly among the types of containers. In particular, cowpot, peat and wood fiber biocontainers were found to have low wet strength that would be problematic for users. Peat, straw, cocofiber and wood fiber biocontainers required significantly more water to grow a crop to a marketable stage than other biocontainers as well as traditional plastic containers. Ricehull and OP47 biocontainers had physical properties similar to plastic containers. Trials were initiated to evaluate biocontainer performance when used for long-term greenhouse and containerized nursery crops.

Impact

The information generated from this research will allow manufacturers to improve biocontainers and will help greenhouse and nursery managers make decisions regarding which biocontainer(s) are most suitable for their operations. Ultimately, the results of this research will help to reduce the use of petroleum-based plastics in greenhouses and nurseries.

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Funding

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

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 2008-2009. The overarching 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 efficiency of methods used to identify woodcock locations. A graduate research assistant was hired and conducted field work during the winter of 2009-2010. Field work consisted of conducting crepuscular (dusk) surveys of woodcock in 3 different stages of regenerating pine plantations (new cut, regenerating pine, young pine) to understand how woodcock use different seral stages of regenerating pine. Several undergraduate volunteers assisted with data collection. Research assistants also measured vegetation structure and composition within the study sites. Field work will continue during the winter of 2010-2011. The project will be completed by August 2011. Researchers also investigated the use of thermal imaging to detect woodcock along routes comprised of forested stands and openings.

Impact

Preliminary results suggest a definitive temporal and spatial pattern of woodcock use of different seral stages of regenerating pine. From preliminary results, it appears fewer woodcock use young pine than new cuts or regenerating pine during early migration (January-February). Additionally, when numbers of birds using young pine and regenerating pine are dropping in mid-February, numbers of woodcock using new cuts are peaking. This pattern suggests possible intraspecific variation in use, or use by different populations of woodcock (i.e., birds present in January and February were those wintering in central Arkansas whereas birds present in mid February-March were those that winter further south and were using areas in central Arkansas as stopover habitat). 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 woodcock conservation strategies.

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Funding

University of Arkansas at Monticello Faculty Research Grants, U.S. Fish and Wildlife Service; 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. 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. Three undergraduate research assistants and a research technician constructed 40 hair snares on timber industry lands in Drew County, Arkansas. Snares were baited with fermented corn and were operational for 5 weeks during spring, summer, and fall (2010). A winter 2011 sampling period will occur in January 2011. This project will be completed in the summer of 2011.

Impact

Preliminary results suggest there are to be 2 groupings of feral hog activity in Drew County: one in the northern part, and one in the southern half of the county. Hog presence was detected more frequently through hair samples than by track presence. The number of tracks detected at stations ranged from 3 to > 50, suggesting that individuals and groups of hogs are visiting the stations at various times and locations. The number of hair samples extracted from stations ranged from 1 to 9. At the station where 9 hair samples were collected, there were more than 50 tracks present. This observation suggests

that when groups of hogs come into the hair snare/tracking station, we may be able to identify group size pending genetic analysis. Other non-target species recorded from tracks or hair samples included raccoons, opossum, black bear and deer. Evidence of non-target species were observed at 8 stations, and may have appeared to interfere with detection of hogs at the station. For instance, 6 stations where hog presence was “missed” indicated presence of one or more non-target species. Thus far, we can conclude that hair snare/tracking stations baited with fermented corn are successful in detecting presence of feral hogs; however, reliability will be quantified after the conclusion of all sampling periods. Upon completion of this project, we will have a quantitative measure of the reliability of using this method to document the presence and spatial/temporal use of areas by feral hogs. Geographic information system analysis should indicate landscape variables important for predicting hog presence. This information will be valuable in developing hog control strategies.

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

Assessment of Northern bobwhite quail (*Colinus virginianus*) survival and fitness at Felsenthal National Wildlife Refuge, Arkansas

Issue

Northern bobwhite quail (*Colinus virginianus*) numbers have declined in the past several years over much of their range despite implementation of habitat management programs. In Arkansas, northern bobwhite numbers have declined more than 50% since the 1960s. Habitat loss from revolutionized farming practices and land use changes is probably the main contributing factor to quail population declines. In response to declining quail populations, several agencies and organizations including Arkansas Game and Fish Commission, U.S. Fish and Wildlife Service, Arkansas Quail Committee, and Southeast Quail Study Group have identified action items associated with future quail management direction. The main priority is habitat restoration, improvement and maintenance throughout their range. Additionally, there are several ecosystems in which biologists are not as familiar with quail habitat. For instance, there is an abundance of information on quail habitat in Midwestern agro-grassland systems, but quail habitat characteristics within forested areas of the West Gulf Coastal Plain ecoregion are not as well understood. In addition to habitat availability, other underlying factors could be contributing to declining quail numbers. For instance, predation by red imported fire ants and feral hogs have been implicated in quail mortality.

Biologists and managers at Felsenthal National Wildlife Refuge have implemented prescribed fire and timber management primarily to create and maintain habitat for red-cockaded woodpeckers. Historically, these management activities have also created habitat for quail, which prefer grassy openings, shrubby cover, and sparse trees to meet seasonal habitat requirements. Despite management efforts to improve habitat, quail numbers are still declining. Thus, other factors are likely affecting mortality and nest success. Therefore, the objectives for this project are to 1) assess northern bobwhite habitat conditions at Felsenthal National Wildlife Refuge through land cover maps, vegetation surveys, and quail use 2) quantify northern bobwhite survival rates during the nesting and brood-rearing periods, and 3) identify factors contributing to northern bobwhite population declines in southern Arkansas.

Action

We will begin identifying potential trapping locations in October 2010 using simulated call counts at random locations or stratified (based on vegetation type) random locations throughout the study area. Thirty minutes before sunrise on clear, high-pressure mornings, we will play quail call tapes to identify locations of quail establishing their winter home ranges. If there is no response, we will not use those sites as trapping locations. Location and number of observations will be determined based on area extent, and landscape variability.

We will capture at least 30 quail (preferred sample size is 50-60 birds) throughout January-February 2011 and 2012 using traps baited with cracked corn or milo to attract the birds. Traps will be located in areas where quail have been observed by field personnel and in areas where presence has been indicated by the fall simulated call count survey. Captured birds will be fitted with necklace-model transmitters with mortality signal, and located daily during nesting and at least 3 times per week otherwise for approximately 10-11 months or until batteries fail. Survival will be quantified using models such as Kaplan-Meier and correlated with habitat conditions and other factors that may affect survival. Habitat conditions will be assessed by comparing vegetation cover, structure, and spatial characteristics between used and unused areas.

Impact

Implementation of this project will help develop a solid working partnership with U.S. Fish and Wildlife Service personnel at Felsenthal National Wildlife Refuge. Results of this project should reveal causes of quail mortality in southern forested areas, and identify factors to consider in habitat management or quail conservation plans.

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Funding

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Baling co-processed poultry litter and dewatered municipal biosolids

Issue

Since the late 1980s, the Ozarks Plateau region has experienced rapid growth in poultry and livestock production and population growth in the area. This resulted in excess nutrient production from both agricultural sources and municipal biosolids. Increased phosphorus in runoff water into surface sources has often been attributed to these phenomena. Economically efficient movement of excess nutrients into areas of high agricultural productivity could help resolve this issue.

Action

Poultry litter and dewatered municipal biosolids (PL/DMB) were blended, compacted and wrapped in a gas semi-permeable plastic to test nutrient preservation and pathogen destruction capabilities of the baling system on the co-processed product. The PL/DMB was seeded with 500,000 colony-forming units per gram of a non-pathogenic *E. coli* routinely used as an indicator to confirm reliability of food processing procedures. Extensive testing revealed low nitrogen loss from volatilization and elimination of *E. coli* indicators within 90 hours. The USEPA accepted the project report; verification as an approved method is ongoing.

Impact

Numerous leading farmers in the Arkansas Delta experienced encouraging results from use of the baled poultry litter system developed by the Division of Agriculture, now commercialized by White River Fertilizers. In actual farm use by prominent Arkansas farmers, application of one ton per acre produced a 32% yield increase in average yield in 2010 on 500 acres of cotton, using supplemental N to meet soil requirements. This farm will increase use to 3000 acres. A rice farm used 2 tons per acre on severely cut rice ground and obtained yields of 178 bushels per acre, 55% greater than expected. Numerous others have experienced similar results on other crops. This year researchers will undertake the third year of testing of baled, co-processed product (PL/DMB); results to date indicate a soil enrichment program incorporating PL/DMB rather than total reliance on chemical fertilizers results in increased profitability. The Northwest Arkansas Conservancy Authority is considering adopting the PL/DMB system at their regional sewage treatment plant near Centerton. Successful implementation of the system at that site could allow in excess of 200,000 tons of PL/DMB to be moved from the nutrient-excess Northwest Arkansas region to nutrient-deficit row crop production areas in eastern Arkansas and surrounding states.

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Funding

USDA-NRCS; U.S. Environmental Protection Agency;
University of Arkansas Division of Agriculture

Impact of biomass energy crop species and nutrient source on soil sustainability

Issue

Biobased energy has become a national priority in order to gain energy independence. Agriculture can play an important role in a biobased energy economy. However, the environmental sustainability of such an energy economy is not well understood due to crop, management, and regional differences. Crop residues are important in maintaining soil quality and agricultural sustainability by contributing to soil organic matter, which in turn, improves nutrient cycling, water holding capacity, and soil erosion protection. Next generation biofuels (ethanol and other biobased chemicals converted from cellulose) can be produced from perennial and annual grasses. It is critical that impacts of annual and perennial grasses on the soil system be evaluated in order to establish best management practices that limit unintended consequences or that increase the health of the soil system.

Action

A study is being conducted to determine the impact of annual and perennial grasses, and nutrient source on the sustainability of the soil system. For this study, switchgrass, switchgrass co-planted with big bluestem, eastern gamagrass, high biomass sorghum, and high biomass sorghum in rotation with soybean were established in northeast Arkansas. Nutrient sources being tested include urea, pelleted poultry litter, and class A municipal biosolids to determine the effect of nitrogen source on biomass yield and soil health parameters. Soil health is being monitored by quantifying soil organic matter dynamics, as well as other soil biological, chemical, and physical properties. The study site was established in 2009 and is expected to be maintained for 10 years. Samples from this study have been shared with other scientists who are working on ethanol conversion technology for next generation biofuels.

Impact

This study will result in recommendations to growers and land owners with regard to crop species and nutrient source options well suited for biomass production in the Mid South. These recommendations will show yield potentials as well as soil health benefits in order for land owners to make better decisions based on both production capacity and environmental quality concerns. As this new biobased economy develops, management practices that protect the soil, maintain high yields, and limit external inputs will be essential. Land owners who have access to either poultry litter or municipal biosolids can save money and still provide the necessary nutrients while adding very important organic matter resources to improve soil health.

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Funding

U.S. Department of Energy Project # DE-FG36-08BO8803; University of Arkansas Division of Agriculture

Water quality changes in Arkansas' trans-boundary watersheds

Issue

Water quality in streams and rivers draining from Arkansas into our neighboring states has been an environmental concern, resulting in multiple changes in watershed management of both nonpoint and point sources of pollution. Water quality issues impact every citizen in Arkansas, from the rural farmers relying on the agricultural landscape to urban dwellers relying on municipal water and wastewater infrastructure.

Action

The Arkansas Water Resources Center has been collecting and analyzing water samples in streams draining multiple trans-boundary watersheds. These and other data from the U.S. Geological Survey National Water Information Systems database have been used to evaluate changes in water quality of streams and rivers. Several specific studies on water quality have also been completed looking at the effects of municipal effluent discharges, hydrology and land use changes on water quality.

Impact

Water quality (particularly phosphorus concentrations and loads) has decreased over the last several years at many of these streams and rivers, resulting from watershed management changes. The local citizens, municipalities, and state agencies benefit from understanding which management actions result in improved water quality of Arkansas's streams and rivers. The water quality issues in these trans-boundary watersheds could result in costly total maximum daily loads (TMDLs), and our analysis allows everyone to know whether water quality is improving or not in these waters.

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Funding

Arkansas Natural Resource Commission 319 Nonpoint Source Program; U.S. Environmental Protection Agency Region VI; the Cities of Fayetteville, Rogers, Siloam Springs and Springdale, Arkansas; U.S. Geological Survey 104B Program; University of Arkansas Division of Agriculture

"BugFest" helps educate public about insects

Issue

Arkansas citizens are constantly being presented with insect related issues by the mainstream media, with most stories being alarming in nature (e.g., bed bug epidemics, west Nile virus sweeping the country, honey bees disappearing due to a mysterious colony collapse disorder, etc.). "BugFest" is an entomological outreach program that presents insects in a less threatening light and is geared toward both youth and adult education.

Action

The beneficial aspects far outweigh any negative impact caused by insects and this message is conveyed through both physical and audio/visual educational display materials presented at the annual "BugFest" event. The program consists of a static display board containing basic entomology and entomology career information, insect collecting information, and a demonstration insect collection. The audio/visual portion of the program includes presentations on "Edible Insects," "Making an Insect Collection," "Imported Fire Ants: Youth Perspective," "The Honey Files" courtesy of the National Honey Board, and "Discover Entomology" courtesy of the Entomological Society of America.

This annual collaborative program between Extension Urban Entomology and the Arkansas Museum of Discovery was begun in 2007, with the latest event held in April 2010. The 2011 "BugFest" event is being planned for April 2011.

Impact

This three to five day educational event has been presented, on an annual basis, to the public since 2007. Total event attendance in 2009 was 2430 and in 2010, 3048. Attendance has increased over time with there being a 25% increase from 2009 to 2010. Audience make up on average has been: adults, 47.8%; children, 46.9%; seniors, 3.7%; and under 1, 1.6%.

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Funding

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Managing high quality putting green turf with reduced environmental impact

Issue

Selection of the proper bentgrass cultivar for golf course putting greens in Central and Northern Arkansas, and identifying best management practices for this growing region, will make a significant long-term impact on golf course man-

agement in the state. Furthermore, improved putting green health may be achieved by identifying practices that maintain acceptable putting quality. Finally, improving summer stress and summer disease tolerance may be achieved by identifying management practices that improve moisture distribution in sand-based putting greens, such as wetting agent application.

Action

Evaluations of 19 cultivars are being conducted at the Arkansas Agricultural Research and Extension Center in Fayetteville. The National Turfgrass Evaluation Program is responsible for funding replicated cultivar trials around the country and has awarded the University of Arkansas Division of Agriculture 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. Two regional, high-end golf courses have used data from this project to select cultivars when renovating their golf courses. 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; United States Golf Association; National Turfgrass Evaluation Program; Golf Course Superintendents Association of America

Bio/nano technology – programmable micro/nanoscale BIO/ABIO interfacing

Issue

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 ranging 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 materials and devices through stable and “controllable” interfaces between bio and abio materials at the nanoscale. Currently, particular emphases are given to the aqueous-phase self-organization of nanomaterials and their composites, which comply with a specific design, with multifunctional, multiplex, multicolor, and multimodal properties that are “programmable and customizable” on the basis of target applications, in particular biological, biomedical and electronic applications. One of the applications includes the development of a photoacoustic and photothermal diagnostic and therapeutic system using unique plasmonic nanoparticles and their complexes.

Impact

This research is an important step towards realization of the bio/nano technology that bridges the sciences of biology, medicine, nano-materials, and MEMS/NEMS by pairing their advantages. The project has high potential to transform many fields of research including biology, chemistry, physics, medicine, and materials science and engineering.

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Arkansas Biosciences Institute (ABI); University of Arkansas Division of Agriculture

Vegetative buffer and windbreak walls in mitigating aerial emission from poultry houses

Issue

Modern broiler production uses a large number of powerful ventilation fans to provide good air quality to high-density chicken houses. Air emissions from these facilities have increasingly become scrutinized in contributing to air pollution and downwind odor nuisance.

Action

Windbreak walls (10 ft by 40 ft) consisting of 5 panels of shade cloth material fastened to steel posts 20 feet away from

another bank of tunnel fans were installed on the Applied Broiler Research Farm. Numerous wind vanes and anemometers were installed in the vicinity of the artificial windbreak wall to quantify the local wind pattern. Smoke bomb tests were conducted to depict wind pattern as affected by the windbreak. Monitoring of particulate matter downwind of the tunnel ventilation fans was conducted in the summers of 2009 and 2010 to evaluate their efficacy as mitigation technology. Guidelines and recommendations for design and maintenance of vegetative buffers and structural windbreaks are to be developed to assist local livestock producers in adopting these affordable, cost-effective technologies.

Impact

A vegetative buffer is a natural barrier for gases and dust emitted from broiler facilities. Structural windbreaks provided immediate mitigation effects for reducing wind generated by powerful tunnel fans and served as a screen for dust emission. The adoption of these simple yet effective management practices demonstrates the growers' environmental stewardship.

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University of Arkansas Division of Agriculture

Stream buffer demonstration for Northwest Arkansas landowners

Issue

Stream buffers are a widely accepted practice for improving water quality, protecting stream health, and providing aquatic habitat. Many federal and state agencies have programs that support the establishment and maintenance of stream buffers by providing cost share funds as well as annual payments to landowners. However many landowners do not utilize these programs because they do not understand the benefits of buffers, what these buffers will look like after establishment, or what is involved with buffer establishment.

Action

Personnel from the University of Arkansas Division of Agriculture developed a plan to establish a variety of buffers along a stream at the University of Arkansas Water Research and Education Center. The intent of the project was to provide a unique demonstration area at one location where landowners and the public could see buffers suitable for both urban and agricultural landscapes as well as buffers that could provide timber products, bioenergy feedstocks, and or wildlife habitat while protecting water quality. Buffer establishment was started in 2008 and is nearing completion.

Impacts

Since the establishment of the demonstration area, a variety of workshops, watershed groups, and undergraduate university classes have used the area for educational and outreach purposes. During the past two years landowner and watershed group educational activities, associated with the demonstra-

tion area, have focused on buffer tree and grass establishment, benefits of buffers, cost share programs, and maintenance of vegetation within buffers. At least four undergraduate classes at the University of Arkansas have used this area to provide soil and water conservation training for the next generation of natural resource and land managers.

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University of Arkansas Division of Agriculture; Arkansas Forestry Commission

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

Issue

The state of Arkansas produced more than 600,000 acres of corn in 2010 with the acreage and crop value both expected to increase in 2011. Corn and corn-related enterprises contributed more than \$300 million to the Arkansas economy during 2010 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 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 from the most recent two years of this study, conducted at two Arkansas locations, indicate that this may be the case. In addition, commercial nitrogen is produced through the Haber process which consumes very large amounts of fossil fuels (natural gas) in the production process and releases large amounts of CO₂ into the atmosphere.

Action

Corn was planted at the Arkansas Agricultural Research and Extension Center 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 Austrian winter field peas planted in the fall and plowed under in the spring, just prior to corn planting. 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. In 2008-2009, winter peas were found to replace between 72 and 150 lbs of N. This can represent up to 50% of the N expenditure. Also, there was a strong location effect, in that highly fertile silt loams with irrigation in Eastern Arkansas were much more responsive than moderately to

poorly fertile silt loam soils in Northwest Arkansas. In some instances, 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

Dale Bumpers College of Agricultural, Food and Life Sciences Unrestricted Teaching and Research Fund; 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 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

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

Issue

The Illinois and White River watersheds in Northwest Arkansas 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 nonpoint source (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 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. However, BMPs in ecological engineering alone 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:

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Funding

U.S. Environmental Protection Agency through Arkansas
Natural Resources Commission; 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 or sediment. If environmentally harmful amounts of pesticides begin to appear in surface water or sediment, early awareness of the situation would make it easier to remedy.

Action

We monitored surface water at four locations on the Cache River and on six small tributaries to the Cache, one site per tributary. Sediment samples were also collected at each site. Sampling was weekly from the middle of May to early July when these pesticides used in rice production would most likely be found. Analysis was for four pesticides and one degradation product plus selected nutrients and pH, dissolved oxygen, and specific conductance. The Cache River was chosen because it had the most detections in our previous studies. Results from the tributaries will allow us to determine how much variability there is between small tributaries and the main Cache. This will allow us to determine if the concentrations found in the Cache are from continuous inputs or are more likely from sporadic inputs from many locations.

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 found more variability in water concentrations of pesticides in the tributaries compared to the main Cache. This is not surprising, since any inflow from a recently treated field would be a higher percentage of the flow in a small tributary than it would be in the main river. Absence of runoff would also allow the concentrations to more quickly drop. Pesticides were seldom found in sediment, and then only at low concentrations. These results indicate that production practices as they are now being done in the rice growing areas are not causing residues of these compounds to accumulate in sediment. Pesticide levels can be higher in the tributaries than in the main Cache, but they also drop more quickly.

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

Integrated resource management tool to mitigate the carbon footprint of swine produced in the U.S.

Issue

In 2008, the National Pork Board adopted a resolution that says the carbon footprint of U.S. pork production is of significant importance to the pork industry and its customers.

Action

We worked with the University of Arkansas Sustainability Center on a Pork Board grant to evaluate the carbon life cycle assessment of the pork industry. This was a scan level analysis involving a review of available literature and involved assisting with the development of the general and detailed models for the pork chain including all direct and indirect inputs for the production systems as well as the harvesting process. We worked with the pork industry to develop a collaborative concept of an overview of the entire swine life cycle carbon footprint as well as a more detailed approach for a minimum of two detailed production concepts.

Impact

With industry collaboration, we were able to accurately assess the carbon footprint of U.S. pork production. This work has been submitted as a final report to the Pork Board entitled “Greenhouse Gas Emissions and Global Warming Potential of the U.S Swine Industry: Review of the Literature from a Life Cycle Perspective” and is to be published in early 2011. This Life Cycle Assessment (LCA) has provided very valuable information identifying potential inefficiencies which, when improved or eliminated, may simultaneously reduce the impacts associated with the process and improve business profitability.

Identification of potential inefficiencies in the pork chain provided the basis for our research group, in collaboration with other research institutions, to develop an AFRI grant proposal to address many of the inefficiencies identified in the LCA. We have assembled an interdisciplinary team from the University of Arkansas, Purdue University, Virginia Tech University, and Applied Geosolutions to perform experimental work, develop models/software tools, and provide training/guidance to facilitate the use of the tools by farmers across the U.S.

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Division of Agriculture

Ozone tolerance in selective native flowering perennials

Issue

Degraded air quality caused by high traffic volume can have an impact on rights-of-way vegetation and urban land-

scapes. Native or adapted resource efficient sustainable plants are preferred to exotic or invasive plant species. Numerous native plant species exist that can be useful in either highway or urban landscape plantings where exposure to degraded air is probable, but little is known about their resistance to ozone gas exposure, a major component of air pollution. This research screened native flowering perennial species with potential in re-vegetation projects or for use in urban environments along streets and medians.

Action

Thirty-five species native to the Ozark region were subjected to acute exposures of ozone gas. Visual symptomology and the extent of foliar damage was recorded and documented. Further testing will attempt to establish damage thresholds and test differential cultivar responses.

Impact

Differential damage occurred along closely related species indicating that screening for ozone tolerance is needed to recommend species for planting in areas with the potential for degraded air quality. A list of species suitable for highway or urban landscape planting will enable highway and infrastructure vegetation managers and landscape designers to better select plant material that is sustainable over time.

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Private forest landowner willingness to accept price offers for woody biomass

Issue

Bioenergy has emerged as a potential alternative to traditional fossil fuels in the United States due to growing concern over national energy security, economic growth, and climate change. At present, energy derived from wood, waste, and agricultural crops contribute a little more than 50% of the total renewable energy produced in the U.S. A large share of this energy produced comes from woody biomass and is consumed primarily by forest products industry and the utility sector for generating heat, steam, and electricity. A number of researchers have identified several potential advantages of utilizing forest-based cellulosic materials as feedstock for energy. Some of these include the maintenance of healthy forest systems by the removal of small and lower quality woods, reduction in greenhouse gas emissions, and promotion of rural economies. Also, as it lies outside the human food chain, woody biomass does not impose a negative influence on food supply and is accompanied with lesser production costs compared to food-based feedstocks. In addition, net energy gain from cellulosic biomass is much higher compared to that obtained from grain ethanol. The South, which occupies 40% of timberlands in the U.S., is often known as the “wood basket” of the country and is considered to be a potential source of woody biomass for future bioenergy production. However, the availability of

biomass from these southern forests is guided largely, among other things, by the decisions made by nonindustrial private forest owners (NIPF) since they form a major forest ownership group. It is therefore critical to understand landowners’ perception towards wood-based energy and their willingness to supply biomass for the successful implementation of bioenergy generation operations in the South. The purpose of this study is therefore to examine NIPF owner willingness to supply woody biomass from their forests for energy production at various hypothetical price levels and to understand the factors motivating them to make such decisions.

Action

The data for the study were collected through a mail survey of NIPF landowners from three southern U.S. States; Arkansas, Virginia, and Florida. Sixteen hundred landowners from each state owning at least 20 acres of forest area were randomly selected for the survey from a list of NIPF owners. The survey questionnaire included four sections seeking information about forest characteristics, biomass and bioenergy, forest management activities, and demographic features of the landowners. A payment table with multiple price options at different certainty levels was used to assess landowners’ willingness to supply biomass. The market price of pulpwood was used as a baseline value assuming that the price of biomass is best represented by the price of pulpwood since small diameter trees have the potential of being used for energy production. Statistical models were then estimated to analyze the factors affecting the certainty levels of harvesting decisions chosen by landowners at different price levels. The results indicated significant association between landowners’ bid acceptance decisions and factors such as, forest tract size, size of trees in the forest, distance of landowners’ residence from the forest, landowner age, previous harvesting experience, market price of timber, and the landowner’s forest management objectives.

Impact

The findings of this study identified the factors influencing market entry decisions of southern forest landowners for supplying biomass from their forests which is crucial for the successful implementation of cellulosic energy generation projects in the future. The results will be useful to decision makers in the biomass energy sector, policy makers and other researchers.

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U.S. Department of Agriculture; Department of Energy; Biomass Research Development Initiative (BRDI); University of Arkansas Division of Agriculture

Private forest landowner willingness to supply woody biomass for energy

Issue

Forest-based biomass for biofuels generation can be obtained from different woody residues that are produced during

timber harvesting and other silvicultural operations, the fuelwood collected from forests, urban wood waste, the residues from mill operations, woody and perennial herbaceous crops and agricultural residues. About 48% of the forestland in the United States and 71% in the South are owned by nonindustrial private forest (NIPF) or family forest landowners. Past studies have shown that timber harvesting decisions of landowners are mostly dependent upon market price, landowner type, bequest motives, size of forest tract, parcelization, environmental preferences, management objectives, and a number of demographic and forest management characteristics etc. Given the environmental and socioeconomic benefits associated with wood-based energy, it is possible that influence of these factors on landowners' decisions to harvest woody biomass for energy may be different than conventional timber harvesting decisions. Similarly, the feedstock for bioenergy can be obtained from the forest without necessarily conflicting with the wildlife management or recreational objectives of the landowners. This study aims to understand different biophysical and forest management characteristics like size of forest parcels, length of ownership, size, structure and composition of tree species, forest management objectives, mode of harvest and demographic characteristics which may be instrumental in predicting landowner willingness to supply woody biomass for energy production.

Action

The study area includes Arkansas, Florida and Virginia. Sixteen hundred landowners from each state were randomly selected for the final survey. The results demonstrated that willingness to harvest woody biomass was influenced by ownership objectives, size of the forest, structure and composition of tree species, and demographic characteristics. The model found that relatively younger landowners who owned large acres of forestland with pine plantations or mix forests had the potential to become a preferable choice for contractors, extension foresters and bioenergy industries as they were more likely to supply woody biomass for energy.

Impact

The findings of this study will be useful to bioenergy industries, extension foresters, nonindustrial private forest landowners and policy makers. It was evident from the study that there is a critical need for landowner education and outreach. The results of this study will be useful to design such outreach efforts.

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

Issue

For decades, in addition to providing energy, natural gas and oil have been used as inexpensive feedstocks for the production of ingredients and packaging materials for the food industry and other industries. However, the continuous use of these non-renewable resources will eventually lead to their depletion or make them too expensive for the production of materials. An alternative is the use of renewable plant materials as feedstocks to produce chemicals. The drawback of this practice is the direct competition with food production for land and resources. An alternative to the use of dedicated agricultural commodities to produce materials is the utilization of co-products from the food processing industry as feedstocks.

Action

We conducted studies to find the optimal conditions to extract fermentable sugars from co-products of the processing of plant materials into food products. Fermentable sugars can be subsequently used for the production of ingredients via fermentation (e.g., lactic acid, ethanol, etc). For these studies, co-products from the canning, pickling, juice extraction, and soybean oil extraction industries were used. Co-products included white potato, carrot, watermelon, cucumber, blueberry and blackberry pomace, and soybean meal. Co-products that contained readily available sugars were disintegrated and the sugars extracted by expression. Those co-products where sugars were part of polymers, e.g., starch, were hydrolyzed with dilute acid to release fermentable sugars. All these processes were optimized to get the best extraction and the sugars were characterized and quantified.

Impact

This research demonstrated that is feasible to extract fermentable sugars at significant concentrations from plant co-products generated by food processing facilities. Fermentable sugars extracted from these co-products could be used as a replacement of fermentable sugars obtained from dedicated agricultural commodities (e.g., corn), thus alleviating in part the downside of using food materials to produce chemicals. A second impact is the reduction of waste material that need disposal, which as a consequence reduces the carbon footprint of food processing plants.

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Arkansas Soybean Board; Institute of Food Science and Engineering; University of Arkansas Division of Agriculture

Improving corn phosphorus (P) fertility recommendations in Arkansas

Issue

Phosphorus is an essential plant nutrient and P fertilization may increase corn yields in Arkansas soils. However, excessive buildup of P in agricultural soils will increase the likelihood of P loss via runoff and pose a risk to water quality. Accurate soil test-based, assessment of soil P fertility and appropriate P fertilizer recommendations are the most effective processes for producing optimum corn yields and reducing the risk of excessive soil P buildup.

Action

Five replicated P fertility experiments were conducted to evaluate corn response to application of 0 to 160 lb P₂O₅/acre in 40 lb P₂O₅/acre increments. These soils were typical of soils used for corn production in Arkansas. Soil texture ranged from silt loam to clay loam and available soil P as measured by Mehlich-3 procedure ranged from Low to Above Optimum.

Impact

Corn seedling P concentration, dry matter accumulation, or P uptake at two of the sites that were rated Above Optimum were not influenced by P fertilization. However, P fertilization significantly increased P concentration, dry matter, and P uptake at one site that was rated Low in P. At this site, P application significantly increased ear-leaf P. Yields at the Low-P testing site were lower than expected and ranged from 122 to 128 bu/acre suggesting that another factor (such as N availability) was more limiting than P availability. Corn grain yields at the other four sites were not influenced by P fertilization. The lack of significant grain yield increases to P fertilization is not surprising since soil-test P was either Medium or Above Optimum at these sites.

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University of Arkansas Division of Agriculture

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

Issue

Given the Obama administration's push to reduce greenhouse gas emissions (GHG) there has been growing talk of a well-established carbon trading market in the U.S. While there is a small, and relatively unused, carbon market that exists now

at \$0.10 per ton of carbon, policy changes are estimated to raise that price as high as \$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 at the county level in the U.S. and Arkansas in particular.

Action

A model was developed to quantify the amount of carbon each of the largest eight crops in Arkansas could sequester in each of its 75 counties. The model took into account the soil portfolio in each county, the tillage practices, harvest indices, and shoot-to-root ratios for each crop in each county. From this, an estimate of sequestered carbon per acre per crop per county could be obtained. The model rewards behavior that enhances net carbon footprint by either lowering carbon emissions or enhancing soil carbon sequestration or both.

Impact

The model set forth a new methodology for measuring carbon emissions as well as providing policy makers the implications of a carbon offset market. The models estimates have been used by commodity groups (Cotton Incorporated) to assess how a carbon offset market would affect cotton producers. The estimates also provide policy makers a snapshot of how various carbon prices will affect cropping patterns and resulting input and output prices.

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University of Arkansas Division of Agriculture; Cotton Incorporated

How consumer demand, industry pressure, and government policy regarding greenhouse gas emissions could affect producer selection of rice cultivars

Issue

The rice industry worldwide is coming under increased pressure to reduce its relatively large carbon footprint. Given increased consumer demand for "greener" products, mounting industry pressure to reduce their greenhouse gas (GHG) emissions, and increased talk of a government carbon policy, the current rice production system may face increased consumer and industry pressure to lessen its environmental impact. There has been a wealth of research on the GHG emissions of rice around the world but little on the differences between rice varieties (conventional, hybrid, and Clearfield).

Action

A model was developed to quantify the amount of carbon released per acre for each of the 14 most popularly sown rice varieties across six counties in the Delta. The model took into account the soil portfolio in each county, the levels of inputs (fungicide, fertilizer, insecticide, herbicide, diesel fuel, water) required to produce each of the 14 distinct varieties. From this, an estimate of GHG emissions in the form of pounds of GHG per pound of rice produced could be calculated for each of the varieties.

Impact

While this methodology is not new, its application is. That is, unlike previous studies that only looked at differences between crops, this study looks at differences of GHG emissions within crop varieties. These estimates will give the rice industry pertinent information on the relative differences, which can be large, between sowing one variety over another. This information can also be used to assist producers if a carbon offset market is to develop. Overall, it gives the industry more information on avenues to explore to lower their overall impact on the environment.

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University of Arkansas Division of Agriculture

Residual oil in Gulf of Mexico marshes and estuaries

Issue

The remaining oil from the Horizon spill over the summer of 2010 is very difficult to remove from marsh and estuary areas because the presence of vegetation does not allow skimming to be used. Aside from toxicity problems from the oil itself, the oil is also food for bacteria that results in bacterial overgrowth and depletion of the dissolved oxygen in the water. Lack of dissolved oxygen is highly detrimental to aquatic species in the area, particularly oysters that require higher oxygen levels than other aquatic life. Oysters are a major source of fishing income in the Gulf areas.

Action

The supersaturated dissolved oxygen injector (SDOX) technology adds dissolved oxygen to shallow, warm water far more effectively than traditional technology. The SDOX is being deployed in shallow warm water areas in the Gulf to determine if sufficient oxygen can be added to support natural bioremediation of oil residual while supporting oxygen levels required for proper reproductive cycles of oysters to occur. Dissolved oxygen plume will be injected into Gulf waters and allow natural tides to feed the plumes into the difficult to reach areas where oysters grow. The movement of the dissolved oxygen plumes will be monitored so full-scale SDOX systems can be implemented to solve the problem broadly over a longer period of time.

Impact

If successful, the SDOX system will allow the oyster fishing industry to recover from the spill much more quickly than would otherwise be possible. Enrichment of the dissolved oxygen environment in the marsh and estuary areas will help the entire ecosystem to recover long term from the impacts of the Horizon spill.

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National Science Foundation; University of Arkansas Division of Agriculture

Removing drug residuals from reservoir sources of drinking water

Issue

Recent water quality surveys of both environmental and drinking water have shown measurable concentrations of drugs, endocrine disruptors and industrial chemicals. One of the major likely sources of these chemicals is treated wastewater that enters the environment from municipal treatment plants. These chemicals are very difficult to remove from the environment and typical wastewater treatment processes do not remove them. These chemicals can be removed from drinking water before it is consumed by humans, but the impacts of the chemicals while in the environment are of concern.

Action

The hyperconcentrated dissolved ozone injection (HyDOZ) system is a commercial system that adds dissolved ozone to water much more effectively and at less cost than traditional ozone systems. Ozone is a powerful oxidizer than can effectively remove the drug residuals, endocrine disruptors, and industrial chemicals of concern at the tail end of the wastewater treatment process prior to release of the wastewater into the environment. Ozone systems are rarely used in current wastewater treatment designs because of the high cost. The HyDOZ system has the potential to significantly reduce the cost of treatment while increasing the effectiveness of ozonation. A commercial scale prototype of the HyDOZ was constructed and tested on a side stream of water at the Springdale, Ark. Wastewater Treatment Facility. Results showed that the HyDOZ was capable of meeting current disinfection standards for the plant at a lower cost than traditional ozone. Significant amounts of chemical of concern were also removed. Further testing and scale-up is being conducted.

Impact

Should the HyDOZ prove economically feasible, municipal wastewater treatment plants could replace existing chlorination and/or ultraviolet systems (that do not remove the drug residuals, endocrine disruptors, nor industrial chemicals) to perform standard disinfection (removal of fecal coliforms) of wastewater while also preventing chemicals of concern from

entering the environment and travelling through the watershed to drinking water reservoirs.

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National Institutes of Health; University of Arkansas Division of Agriculture

Riparian zone management of intermittent streams located in pasture ecosystems

Issue

Water and waterways are crucial resources for the continued economic growth of Arkansas. Riparian zones protect water quality by filtering runoff from urban and rural areas, but in many instances these zones are degraded and have lost their original ecological function. In 2009, an interdisciplinary research and demonstration project was initiated at the University of Arkansas-Monticello to monitor vegetation recovery on the banks of an intermittent stream that drains part of the university campus. This stream dissects several pastures which are used for livestock research projects. This project continued through 2010.

Action

Remediation strategies include various fencing treatments that will allow a comparison of their effectiveness for recovering bank vegetation. These treatments include: 1) One-side fencing of the stream that allows cattle access to the stream but makes cattle traffic through the stream impossible; 2) Two-side fencing with temporary access to forage only during certain times of the year; 3) Permanent exclusion and replanting of trees and shrubs; 4) No fence (control). An additional treatment involving watering devices on either side of the stream will be installed soon. Fencing structures were installed in August of 2009. Trees were planted in treatment (3) during the early months of 2010.

Impact

The changes in plant community and abundance of particular species along the stream banks will be monitored during the coming years. Some of the vegetation recovered already in previously eroded sections of the stream. Furthermore, water samples will be collected at various stream locations to assess changes in water quality over time. Results from our findings will be disseminated to producers, county agents, faculty, and the public during field days, newsletters, or other means of communication.

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Funding

Arkansas Water Resources Center/U.S. Geological Service; University of Arkansas Division of Agriculture

Evaluation of best management practices to reduce total phosphorous runoff under net returns risk

Issue

As environmental awareness increases, management of animal waste has become a crucial issue for livestock producers, poultry producers, the poultry industry and the general public. Several studies have provided evidence of the effectiveness of best management practices (BMPs) in reducing the impact of animal agriculture on water quality. However, an economic evaluation of producers' options when implementing BMPs to control water pollution in nutrient surplus areas is scarce. Consequently, the objective of this research was to develop a procedure to economically and environmentally evaluate a range of management alternatives under uncertain production conditions using stochastic dominance with respect to a function (SDRF).

Action

This study compared 59 different BMPs in terms of net returns risk reduction for hay producers in the Lincoln Lake watershed. Special emphasis was devoted to identifying cost-effective practices to reduce total phosphorous (TP) runoff while maintaining the profitability of agriculture in the watershed. To assess the value of BMPs to reduce TP runoff, SDRF was employed to analyze scenarios. This analysis requires a systems approach combining a number of different models covering hydrologic, economic and risk analysis components of a hay production farming system. The hydrologic model was run to generate TP loading and bermudagrass yield data for each scenario for each subbasin in the watershed. Bermudagrass yield data sets were inputs to the economic model. Yield data were utilized to calculate net returns for each scenario analyzed. Outcomes from the hydrologic and economic models were input to the risk model. This last model was employed to evaluate the impact of decision-makers' risk attitudes on BMP scenario preferences under both net returns and TP runoff reductions.

Impact

This simulation provided evidence that TP runoff in the Lincoln Lake watershed could be reduced without affecting producers' expected net returns when environmentally efficient and economically acceptable BMPs are implemented. Results showed that decision makers will be reluctant to adopt BMPs that reduce drastically their net returns regardless of their water quality benefits. Consequently, decision makers should compare net returns risks and environmental benefits of implementing BMPs to reduce TP runoff, so that producers will be able to select BMPs with the lowest negative economic impact in their hay production operations.

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Funding

USDA CSREES; University of Arkansas Division of Agriculture

Development of turfgrasses with improved drought tolerance

Issue

The availability of adequate potable water in urban environments continues to be a pressing issue. Residential areas, agriculture, and industry are often competing for a finite water supply and landscape water use is often the last segment that is provided water. When these demands are coupled with potential climate change, intense droughts in many regions, and a continued migration of people into water-limited environments such as the desert southwest, the need to identify plants that can survive and thrive on limited water is paramount.

Action

Since 2005, we have worked closely with several private turfgrass breeders to screen and identify turfgrass cultivars that have improved drought tolerance and reduced water use. We have already conducted large scale trials using tall fescue, bluegrasses, perennial ryegrass, and bermudagrass. In the process, we have developed and fine-tuned a screening and statistical analysis method that allows a large number of turfgrasses to be screened efficiently and economically, such that the methods can be readily applied to other turfgrasses or landscape plants in the future.

Impact

The results of these studies have already been recognized by turfgrass breeders and seed companies as a means to identify both superior breeding material in their genetic resources and to identify existing cultivars that can be marketed and sold for reduced water consumption. Several of these companies are developing branding programs that allow consumers a better opportunity to purchase turfgrasses with reduced water requirements. The success of the program is also recognized by the adoption of this screening and statistical protocol by the National Turfgrass Evaluation Program, which is the preeminent program for testing turfgrass germplasm in the U.S. In addition, there is now interest from municipalities and water districts to utilize this information in the development of specifications for landscapes that require less water.

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Funding

University of Arkansas Division of Agriculture; National Turfgrass Evaluation Program; NexGen Research; Pennington Seed; Pure-Seed Testing; Seeds West

Biodrying-gasification of dairy manure – wheat straw mixture

Issue

The increase in size of animal farms, their proximity to urban centers, and the restrictions on manure soil application makes manure disposal a challenge to livestock producers. The high moisture content of manure makes it difficult to convert to fuel via thermochemical conversion processes. This study explored a two-stage approach to convert wet dairy manure, along with wheat straw, to gaseous fuel. The first stage investigates biodrying as a renewable, cheap alternative to reduce the manure moisture, thus making it fit for thermochemical conversion. The second stage investigates the gasification process on the biodried mixture to generate gaseous fuel.

Action

As-excreted dairy manure, and chopped wheat straw were mixed to achieve initial moisture content of about 60%. Only air was used to enhance the biological activity of the microorganisms that naturally exist in the manure. The temperature rises naturally to about 140 °F within the first two to three days resulting in a significant reduction of manure moisture content. This technique used less energy to reduce manure moisture content compared to any other conventional method. Then, the the biodried mixture was fed to the gasification system (at 21% moisture content) and successfully converted to fuel gas.

Impact

Results of this study showed that the moisture content of manure could be reduced significantly with minimum energy usage. It also showed that prolonged conversion of biodried dairy manure/wheat straw mixture to medium heating value gas and replacement of natural gas would supply cheap energy to the livestock producers from an abundant byproduct source. This study was applied to dairy manure, however it would be a valuable technique for all wet manure types.

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California Energy Commission; University of Arkansas Division of Agriculture

Interpretation of *E. coli* reduction after wastewater treatment disinfection may depend on choice of enumeration method

Issue

Treating wastewater to destroy pathogens and control the spread of antibiotic resistance among bacterial populations is fundamental to human health. *Escherichia coli* is a known host for antibiotic resistance genes and is a bacterial species used as an indicator of fecal contamination of water. Although methods to quantify bacteria in natural environments are imperfect, we need to be able to quantify destruction of bacteria, and ultimately genes encoding antibiotic resistance, during water treatment and disinfection. Thus, we are investigating two methods of enumeration of *E. coli*. There are methods to quantify bacteria based on our ability to grow bacteria in culture and there are methods to quantify bacteria based on unique DNA sequences in bacteria. We wanted to investigate how a newer, molecular (DNA-based) method compared to an accepted cultivation-based enumeration method in water undergoing treatment and disinfection.

Action

Water samples were evaluated during wastewater treatment in 2010 before and after disinfection for the presence and destruction of *E. coli* bacteria. Two wastewater treatment plants (WWTPs) were sampled; one WWTP utilizes chlorination and the other uses UV-irradiation for disinfection. A fragment of an *E. coli*-specific gene was targeted and quantified, and *E. coli* was also enumerated using a recognized standard culture-based method.

Impact

Both chlorination and UV irradiation significantly reduced *E. coli* when assessed with a cultivation-based method. However, culture-based enumeration underestimated *E. coli* abundance compared to the quantitative molecular analysis. Results indicate that, despite destruction of a large percentage of cells, DNA is released from WWTPs. Because DNA may carry genes that encode specific advantages for bacteria, such as antibiotic resistance genes, both disinfection methods and quantification of the relationships between active bacteria and DNA encoding specific genes deserve further investigation.

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Funding

National Institute of Health Small Business Technology Transfer research grant; University of Arkansas Division of Agriculture

Available nitrogen concentrations in soil growing tall fescue may depend on earthworm evolutionary origin and ecological niche

Issue

Earthworms are ecosystem engineers and keystone species and, as such, they can have a profound influence on soil ecology. Both native and non-native worms can inhabit ecosystems in Arkansas, and it is still not well understood how the relationships among native and non-native earthworms influence belowground communities and nitrogen cycling in managed grasslands.

Action

Fields growing tall fescue infected with either the toxic *Neotyphodium coenophialum* endophyte (E⁺) or the non-toxic *Neotyphodium coenophialum* endophyte (NE⁺) were surveyed weekly for earthworm populations in 2007. Laboratory incubations were also conducted in silt loam soil with E⁺ and NE⁺ tall fescue litter and plants. Soil cores contained no, native, non-native, or a mix of native and non-native earthworms. Nitrogen was quantified in different soil and plant pools.

Impact

Results from the field surveys indicate that fescue pastures can be converted to NE⁺ without altering earthworm communities. Results from the laboratory incubations indicate that, if there are introductions of non-native earthworms, N cycling can be altered. Changes were measured in available N in soil, but increases in microbial or plant biomass have not been detected in analyses conducted to date. While analyses are ongoing, the fate of available N, nitrate in particular, under E⁺ tall fescue in the presence of native versus non-native earthworms needs further investigation. These results have implications for retention of N within pasture systems.

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Funding

CSREES NRI Soil Processes SEED Grant; University of Arkansas Division of Agriculture

Ecosystem management to balance water quality protection for multiple-use water bodies

Issue

Accelerated eutrophication can deteriorate water quality. However, the need or desire to limit algal biomass in lakes for water quality purposes has created a paradox for ecosystem management. Simply put, highly transparent and unproductive

waters cannot support a highly productive fishery. Therefore, waters that are managed solely for drinking water quality and/or aesthetics will not produce high densities of large fish, which is another important management outcome for most water bodies.

Action

We are exploring new tools and techniques to manage nutrients in diverse water bodies. Nutrients entering water bodies from watersheds must not be excessive so as to promote the harmful effects of accelerated eutrophication. This is particularly important for water bodies that are used as drinking water sources and for contact recreation. However, ecosystem management is needed in water bodies that are intended to support a healthy and sustainable sport or subsistence fishery. We are exploring a variety of management techniques using whole-ecosystem experimental manipulation in the Bella Vista Lake District surrounding Bella Vista, Arkansas.

Impact

Results of these studies will help us understand how to best manage ecosystems so that we promote a healthy and vibrant sport fishery while also maintaining excellent water quality. Our studies will result in specific management recommendations for the Bella Vista Property Owners Association that will allow them to either: 1) use chemical fertilizers in their lakes within the scope of the Arkansas Natural Resources Commission Title 22, or 2) fertilize their lakes with artificial upwelling that will eliminate the need for chemical fertilizers.

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Funding

Bella Vista Property Owners Association; University of Arkansas Division of Agriculture

Development of the Discovery Farm for Arkansas Program

Issue

Farming in Arkansas is under increasing pressure to manage nutrients in an environmentally sustainable manner. In many sectors of the farming community, this has created severe constraints to remaining economically viable and competitive in today's global marketplace.

Action

The Discovery Farm Program was initiated by the University of Arkansas Division of Agriculture, with support from the Arkansas Natural Resources Commission, Commodity Boards, Arkansas Farm Bureau, Arkansas Association of Conservation Districts, Natural Resources Conservation Service, and Beaver Water District. Stakeholder and Technical Committees were established to oversee the program. Four Discovery Farms were selected, memorandums of understanding developed

and approved, and field monitoring equipment installed. The farms are in Washington County (poultry/ beef operation), Conway County (beef grazing), Cross County (rice/soybean), and Arkansas County (rice/soybean/corn).

Impact

Documenting environmental impacts of Arkansas farming systems, as well as evaluating the efficacy and cost-effectiveness of alternative practices, will bridge a knowledge gap that now keeps farmers, natural resource managers and decision-makers alike from confidently taking effective actions that ensure both economic and environmental sustainability. This program and the formation of strong partnerships have the potential to affect millions of agricultural acres across the state. Program results will also give all of us the confidence that we are doing our part to maintain safe and affordable food supplies while protecting our natural resources for future generations of Arkansans.

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Cooperators

Arkansas Natural Resource Commission, Natural Resources Conservation Service, Arkansas Association of Conservation Districts, Arkansas Farm Bureau

Funding

University of Arkansas Division of Agriculture; Arkansas Natural Resources Commission; Natural Resources Conservation Service; Arkansas Association of Conservation Districts; Arkansas Farm Bureau; Commodity Boards, Monsanto

Revising the Arkansas phosphorus index

Issue

The Arkansas phosphorus (P) Index, which is used in nutrient management plan development for all farms in "nutrient surplus watersheds" in Arkansas and as such is the planning tool for determining appropriate land application rates of P (as poultry litter, swine slurry, dairy manure or biosolids), had not been endorsed by the University of Arkansas Division of Agriculture, due to a lack of scientific consensus. Settlement Agreements between various entities in Oklahoma and Arkansas and pending litigation mandates that a revised P Index be developed and adopted by all stakeholders.

Action

University of Arkansas Division of Agriculture researchers and extension personnel collaborated with vested state and federal agencies in developing a state-of-the-science revised phosphorus index acceptable to all stakeholders. The committee is now developing an Index for row crop systems in Arkansas.

Impact

A single risk assessment and nutrient management planning tool, endorsed by the Division of Agriculture and other state and federal agencies, that is based on scientific consensus was developed and approved for statewide implementation

January 2010. The revised P Index has been used to assess the risk of P loss in runoff and approved rates of P applied as poultry litter, swine slurry, dairy manure or biosolid.

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Cooperators

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Funding

University of Arkansas Division of Agriculture; Arkansas Natural Resource Commission

Evaluation of cropping systems and polyacrylamide applications on the distribution and leaching potential of nitrate-nitrogen

Issue

It has been reported that nitrogen that is lost into the Arkansas Delta can be transported to the Mississippi River Basin, potentially contributing to the nitrate load to which the hypoxia problem in the Gulf of Mexico has been attributed. Finding effective methods of reducing these nitrogen losses requires the development and validation of new tools that can be used to conduct quick assessments of how management practices may affect nitrogen losses.

Action

Field studies were conducted in 2008, 2009, and 2010 to collect data to test the new NLEAP-GIS 4.2 model and its capability to simulate nitrogen dynamics for different cropping systems in Arkansas at Arkansas State University and at the Judd Hill Plantation, an environmentally sustainable farm. An evaluation of polyacrylamide (PAM) in irrigated systems was performed for the impact of soil runoff and the potential loss of nutrients.

Impact

The first NLEAP-GIS 4.2 simulation for this region, which analyzed cotton, soybean and corn grown in the Arkansas Delta, showed that the model was able to accurately simulate nitrogen dynamics and the effects of management on residual soil nitrate ($P < 0.01$). The use of PAM for the reduction of soil runoff and the loss of nutrients had no significant impact on nitrate-nitrogen.

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Funding

University of Arkansas Division of Agriculture

Modeling pine as a carbon sequestering crop in Arkansas

Issue

Producers and policy makers require additional information on the role agriculture may play in climate change. This includes 1) greenhouse-gas (GHG) emissions from direct and indirect sources from agriculture production and 2) the ability of agriculture crops to sequester carbon long term in the soil or agricultural products. Further, spatial detail at the county level would provide insights for industry siting decisions when considering alternative crops. In Arkansas, alternative crops dedicated for carbon sequestration and biomass production for alternative energy include switchgrass, black willow, forage sorghum and loblolly pine. The issue is how pine and climate change policies targeted at reducing carbon footprint would impact Arkansas' agriculture.

Action

An existing crop model was modified to determine how producers might alter their cropping decisions with loblolly pine added as a designated carbon sequestering crop at various carbon offset prices. A baseline scenario estimated the current state net returns, land use and net carbon footprint using five year average commodity and input prices (2005-2009) under the assumption of 2007 production technology with the present Chicago Mercantile Exchange (CME) price for carbon. For baseline alternatives, producers were awarded for lowering net carbon footprint relative to the baseline at different carbon offset price levels.

Impact

Adding pine to corn, rice, grain sorghum, cotton, wheat, pasture, soybeans and hay land-use choices at \$5, \$15, and \$30 per ton of carbon increased pine acreage. At \$15/ton, pine began to replace pasture primarily in the northwest and central portion of the state. At \$30/ton, pine entered Arkansas' traditional crop producing counties in the Delta. Overall estimated state net carbon footprint decreased with the increase in carbon offset prices. This increase was driven more from increased carbon sequestration rather than a decrease in emissions. Estimated state net returns improved as a result of the availability of a new carbon market and increasingly so at higher carbon prices.

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Funding

Mid-South Bioenergy Consortium; University of Arkansas Division of Agriculture; Cotton Incorporated

Pesticide safety education program 2010

Issue

Pest management is a very broad area encompassing agriculture, urban situations, public health concerns, trade issues,

etc. The Environmental Protection Agency (EPA) requires that pesticides be used properly and judiciously. The Agency also requires that most individuals and businesses applying pesticides receive proper and recurrent training on the proper use of pest control products. The pesticide safety education program in Arkansas is the primary way that pesticide applicators are instructed on the proper and safe use of pesticides.

Action

Approximately 4,500 Arkansas agricultural producers were certified or recertified as private pesticide applicators during the 2009/2010 training season. These people were certified/recertified at two to three hour pesticide applicator training (PAT) sessions conducted statewide by county extension agents. The PAT training includes information on pesticide labeling, safety precautions, first aid, protective gear, storage, handling, disposal, integrated pest management, environmental concerns, application equipment and calibration, groundwater protection, pesticide recordkeeping, and spray drift management. Approximately 20,300 private pesticide applicators must receive training for recertification at least once every five years.

A total of 1,833 individuals were certified/recertified as commercial or non-commercial applicators at 21 PAT sessions in 2010. The training programs for the commercial and non-commercial applicators emphasize professionalism, human safety, and environmental safety. Tests are required to obtain initial certification. The Arkansas State Plant Board administers the tests.

Impact

Previous grower pesticide-use surveys have indicated that approximately 50% of the respondents have changed their pesticide practices as a result of attending a PAT session. The most common changes listed were increased use of protective gear, reading the label more closely, and more attention paid to calibration. Approximately 85% of survey respondents rated the recertification sessions as good to excellent. In addition to providing training for pesticide applicators in need of certification and licensing, we also provide pesticide safety education to various other groups and individuals. Master Gardener members, private applicators that do not need to be licensed because they don't use restricted use pesticides, city/county/state employees wishing to improve education and reduce liability, are all trained on the safe use of pesticides. The goal and ultimate impact of pesticide safety education is to ensure that individuals use the latest technology and information to handle pesticides (includes purchasing, mixing, applying, and disposal) in a responsible manner.

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Cooperators

Various extension specialists help with the training sessions to provide expertise in relative disciplines

Funding

Registration fees paid by attendees to extension sponsored certification/recertification training sessions; Arkansas State Plant

Board; USDA/NIFA and EPA; University of Arkansas Division of Agriculture

Small mammal communities associated with cottonwood and switchgrass biomass feedstock production

Issue

Arkansas is especially well suited for large-scale biofuel feedstock production due to its productive soils, relatively long growing season, central location within the United States, and well-developed agricultural infrastructure. However, societal desires to ensure that a variety of ecosystem services are provided and protected will influence decisions related to cellulosic-based biofuel feedstock production. A concern associated with the expansion of bioenergy feedstock production in the Lower Mississippi Alluvial Valley is that marginal land currently forested or managed for wildlife habitat in conservation programs will be converted to corn or soybean production due to the high market values of these crops. Cropping systems that combine trees with other potential biofuel crops such as switchgrass may provide more environmentally friendly approaches to biomass production than some currently used systems, such as for corn and other row crop production. Our objective was to investigate small mammal communities associated with cottonwood/switchgrass agroforest systems. Small mammals were chosen as the focal species because they serve many important ecological roles, such as functioning as a primary prey base for several predators, aiding in plant nutrient procurement by dispersing fungal spores that form root-inhabiting ectomycorrhizae, and impacting the regeneration of plants through consumption and dispersal of seeds.

Action

The study was conducted in three agroforest systems composed of diverse mixtures of cottonwood trees and switchgrass that were established at three sites of marginal soil quality located along the Lower Mississippi Alluvial Valley from northeast Arkansas through northeast Louisiana. At each site, treatments consisted of plots composed of 100% cottonwood trees, 100% switchgrass, 67% cottonwood and 33% switchgrass, 67% switchgrass and 33% cottonwood, and 100% soybeans. Small mammal trapping was conducted in the summer of 2010. A total of 233 individuals representing 5 species were captured. The most commonly recorded species was the hispid cotton rat, which accounted for more than 97% of the captures. Other species included the deer mouse, house mouse, eastern wood rat, and marsh rice rat. The 100% switchgrass treatment accounted for the largest number of individuals (94), while the 100% cottonwood treatment accounted for the least (13). Treatments that contained some portion of switchgrass had more small mammals than treatments that did not include some component of switchgrass. The importance of switchgrass to small mammal presence was likely due to the structural cover that was provided, though this relationship may change as these treatments mature over time.

Impact

Documentation of small mammal composition and num-

bers associated with cottonwood/switchgrass biomass production systems provides a basis by which to evaluate ecological relationships associated with bioenergy feedstock production. Management practices that influence biomass production will likely influence small-mammal community characteristics. An increased understanding of these relationships will aid natural resource managers in developing bioenergy agroforest systems that can address production needs while also addressing, and perhaps enhancing, ecosystem services.

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Funding

Arkansas Forest Resources Center; USDA Southern Region Sustainable Agriculture Research and Education Program; SunGrant Initiative – South Central Center; Department of Transportation; Department of Energy; Dept. of Agriculture; University of Arkansas Division of Agriculture

Avian community dynamics following bottomland hardwood harvesting

Issue

Bottomland hardwood forests are an important component of the Lower Mississippi Alluvial Valley landscape. Conservation of biodiversity in managed bottomland hardwood forests is an increasingly important issue, and an understanding of how harvesting and regeneration influences important faunal elements is critical for making informed management decisions. Songbirds are an ecologically important faunal group that can be influenced by structural and floristic habitat alterations that may result from management activities. Songbirds help facilitate seed and fungi dispersal, help control insect numbers, play essential roles in food web dynamics, and can create habitat for other wildlife species through excavation of cavities. In addition to their ecological values, nongame birds are important as a recreational resource to millions of people who watch and feed birds. Neotropical migratory birds are of particular research interest due to recent evidence of long-term population declines in many species. Our objective was to document annual changes in avian communities in response to different types of harvesting in bottomland hardwood forests.

Action

The study was conducted in a mature bottomland hardwood forest located in the Lower Mississippi Alluvial Valley and adjacent to the Mississippi River. Three harvest levels were implemented on nine 50-acre treatment plots. Three plots were clearcut (100% harvest), three plots were partially cut (50% harvest), and three plots were retained as controls (0% harvest). Breeding birds were sampled annually in the spring and early summer for eight years following harvests. One year prior to harvesting, a total of 815 individuals representing 28 species were recorded. Following harvesting, an 8-year total of 13,826 individuals of 47 species were recorded. During the 8 years, 3,919 individuals of 45 species were documented in the clearcut treatments, 5,089 individuals of 43 species in the partial-cut treatments, and 4,818 individuals of 38 species in

the control plots. Several species of regional conservation importance were documented as was the brown-headed cowbird, an ecologically significant nest parasite. Species had differential responses to harvest treatments. For example, the painted bunting was absent from all pretreatment plots, but began increasing in numbers 2-years post-treatment in the clearcut plots while remaining absent in other harvest treatments. In contrast, the eastern wood peewee increased significantly immediately after harvest of the partial-harvest plots but not in the other treatments. However, it began declining in numbers after the second year post-treatment. Differential species' responses were likely due to specific habitat compositional and structural components associated with each harvest treatment.

Impact

Documentation of avian composition and number trends associated with bottomland hardwood forest harvests provides a basis by which to evaluate ecological relationships associated with different management scenarios. Different harvesting techniques influence avian community characteristics, and these characteristics will change with time since harvest. An increased understanding of these relationships will aid natural resource managers in developing management approaches that can address production needs while also addressing avian and biological diversity, and perhaps enhancing ecosystem services.

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Funding

Arkansas Forest Resources Center; Anderson Tully Company; University of Arkansas Division of Agriculture

Integrating soil and water conservation and pest management strategies for sustainable cotton production

Issue

Extraordinary progress has been made in the past decade in improving soil conservation and incorporating pest management in U.S. cotton production. Progressive cotton producers are capitalizing on new opportunities to develop sustainable, efficient, and practical systems that allow cotton production in a more wholesome and healthy environment. Arkansas has been a world leader in sustainability in cotton. On-going work at the Judd Hill Foundation in Northeast Arkansas is providing an ideal environment for the integrated systems approach needed to further develop, refine and demonstrate sustainable production methods. A sustainable cotton production system ensures farm profitability while protecting soil and water quality. The focus of this project is to examine increasing sustainability of cotton systems by improving adoption of technology that makes sustainable practices such as reduced tillage, irrigation scheduling, improved soil health, and integrated pest management (IPM) work better.

Action

A multi-disciplinary systems research project directed at improving sustainability of Midsouth cotton was initiated in

2007. Work has included field studies in reduced-tillage cotton cropping systems to evaluate the impact of winter cover crops and conservation tillage on cotton yield, fiber quality, water quality, soil biological quality, compaction, and pest management. Objectives included evaluation of effects of soil conservation practices on water quality of irrigation runoff as well as evaluations of “soil health.” We have also included work to make practical and relevant measures of progress in improving environmental and ecological sustainability. Efforts to expand sustainability education among producers and in the rural community with program events and outreach activities also have been included.

Impact

Results from a 3 year field study indicate no benefit from the use of automatic pesticide applications for insect control. A sustainable cotton system incorporates an insect pest management (IPM) strategy which does not include automatic, preventative foliar applications of insecticides. Such applications result in unneeded additional expense and pose risks for environmental contamination. Water quality assessments of run-off from field plots showed total suspended solids were consistently lower in edge of field collections from cover crop systems in runoff from rain and irrigation events over the 3 year period. Fewer events of toxicity in runoff water from cover crop and no-till plots were measured. Economic comparisons of each system indicate inputs in the conventional and cover crop systems to be \$11.75 to \$14.00 more per acre than no-till. In 2010, yields were comparable across all systems. In an extensive evaluation of eleven years of farm records from a large commercial northeast Arkansas farm, adoption of conservation tillage practices resulted in reductions in diesel fuel use per acre of 6.1 gallons per acre. Fuel consumption was 13.7 gallons per acre with average yield of 822 lbs of lint when production was 100% conventional tillage in 1997. In 2007, with adoption of herbicide tolerant transgenic varieties of cotton and conservation tillage systems employed across the farm, fuel consumption dropped to 7.6 gallons per acre with average yield increasing to 1296 lbs lint. Reduced fuel usage per pound of lint translates to economic savings that are important to farm profit as well as to environmental health—each contributes to a sustainable system.

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Funding

Cotton Incorporated, Core Funds and the Arkansas State Support Committee; Judd Hill Foundation, Arkansas State University; University of Arkansas Division of Agriculture

Ants in recently disturbed pine forests advance our understanding of the consequences of forestry activities

Issue

Changes in southern forests may be driven by market demands or by conservation concerns. Management intensification to meet these demands is growing. This means there is an increasing area of forest disturbance, which surely foretells longer-term changes in plant biodiversity, and with it animal biodiversity. Given these changes, little information is available for the southern U.S. on how insects are affected by forestry activities such as thinning and burning or how insect communities recover from such activities. Studies are underway in southeastern Arkansas to investigate the ant communities that live in forested landscapes influenced by forestry practices. Ants are a common life form in most terrestrial environments, playing a leading role in ecology as predators of ground dwelling invertebrates. These studies should discover which species of ants are positively and negatively influenced by various forestry practices, and how these ant communities recover from such activities. This information may be used to help land managers improve the quality of their management decisions.

Action

The influences that forestry practices have on ants were assessed by relating ant species assemblages based on pit-fall sampling on pine sites at Warren Prairie Natural Area in Drew County Arkansas, which was recently disturbed by thinning, burning, and grinding, and by combinations of these treatments. Cluster analysis was used to analyze the relationships between the ant communities and the forest treatments.

Impact

More than 30,000 ants were collected, including 47 species and 24 genera. The analyses showed that there is considerable variation in both the ant species present and in their numbers collected within the treatments studied. Because no clear patterns based on treatments were seen when the cluster analysis grouped the ant communities, it is concluded that the ant community is not very sensitive to the burning, thinning, and grinding treatments, or their combinations. Nonetheless, the check plots had the highest species richness, which shows that disturbance can reduce species richness. This is not a new idea. Often, however, disturbance increases species richness because habitat generalists are encouraged and habitat specialists are hindered. This effect is rational because most ants are opportunists and even habitat specialists can eke out a living in the smallest of habitats within the larger disturbance. Most of the species collected are common inhabitants in both the pine and hardwood forests of southern Arkansas. For practical purposes, Warren Prairie includes a mix of forest stands affected by various management treatments. Perhaps most important is that the distribution and mix of treatments within the Natural Area is almost certainly more important for the ant community than specific management treatments. Of the treatments studied, fire is perhaps the least injurious. It is often fleeting, burn today and recovery begins tomorrow. Grinding too can be fleeting; after the machine passes, new wood begins to rain

onto the forest floor. Thinning however has a longer-lasting effect—perhaps decades—because of its effects on plant composition.

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Funding

Arkansas Natural Heritage Commission; University of Arkansas Division of Agriculture, Arkansas Forest Resources Center

Sealed poultry litter bag storage: a promising innovation

Issue

Storing poultry litter is often necessary. Usually the cited justification for storage is protecting surface water from rain induced runoff from exposed litter storage piles. While the environmental concerns are pertinent, often overlooked is the degradation of litter's physical and chemical properties and associated reduction in litter value when exposed to the weather. At times a structure or stacking shed is economically feasible due to the combination of repeated storage need, storage volume, and consistent storage location. An example of this is a stacking shed used on a poultry farm to store the small portion of crusted litter removed after each flock. Often, however, the volume of litter to be stored and variable storage locations make a storage structure uneconomical. A temporary litter storage method is recommended when stacking sheds are not appropriate. However, the use of tarps and other plastic sheet are problematic for various reasons.

Action

This pilot project initiated investigations into the use of large polyethylene bags to store litter. These bags, or tubes, range in size and weight when used for cattle silage and grain storage. For this project, 9 mil grain bags that were 9 foot in diameter and up to 200 feet in length were used. In several field trials, modified grain handling equipment was used to load the storage bags. These trials demonstrated that the equipment was able to pack the poultry litter in the bags with the resulting storage capacity of approximately 1.5 tons/linear foot of bag. An associated storage trial comparing bagged litter to litter stored in an exposed open pile indicated that the bagging not only protected the litter from the weather and prevented runoff, it also appeared to seal the litter preventing nutrient and carbon losses as compared to the litter stored in the open pile. After almost 18 months of storage, the polyethylene bag was still providing weather protection. When the bag was emptied and land applied the litter was found to be uniform in texture and handled well in the loading and spreading process. In contrast, litter that is exposed to the weather for extended periods of time is often crusted on top and has a higher moisture content at the bottom of the pile, which has an adverse

impact on litter handling. At this time, additional research and demonstration opportunities are being sought.

Impact

While this is an investigated project and additional research and demonstration are needed to further quantify potential benefits, equipment refinement, and cost effectiveness of the practice, it shows great promise of having both environmental and production benefits.

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Funding

University of Arkansas Division of Agriculture; Delta Grain Bags Systems, Inc.; US DOE

Energy efficient lighting technology demonstration for poultry production

Issue

Lighting represents a significant energy cost to poultry producers. Research delineating improved efficiency of lighting systems will aid poultry producer profitability.

Action

The primary goal of this project was to demonstrate how the existing technology of incandescent bulbs, cold cathodes (CC) and dimmable compact fluorescents (CF) could be replaced by light emitting diode (LED) technology without impairing bird performance while at the same time providing growers with energy savings and a durable, long-lasting light source which could reduce the labor associated with replacing bulbs. Phase I of the grant began by identifying 18 participant farms where one of the six energy efficient light bulb technologies was installed as grow-out bulbs. The 3 LED technologies include two 10 watt and one 6 watt bulb supplied by Power Secure, NextGen Illum. and Luma Vue, respectively. Installation of new lights began in late February and was completed by July. Bird performance has been monitored and average foot candle of light output measured after each flock.

Impact

The LED technologies demonstrated on poultry farms in this project are proving energy efficient, saving producers as much as 81-84% in lighting costs compared to incandescent bulbs. The LED bulbs are also durable with no bulb failures to date as compared to significant bulb failures for the dimmable compact fluorescents (25%). Another positive result for the bulbs is the minimal loss of light intensity over time as compared to the compact fluorescents. After two flocks, the LED bulbs still provided an average of 80% or more footcandles as compared to their initial new average footcandles. After two flocks, the compact fluorescents provided less than 70% of their initial average footcandles. While loss of lamp lumens or bulbs has not been as significant a challenge with the cold cathode bulbs, the ones currently utilized by the industry and

used in this test have a very limited initial light output which is resulting in lighter birds at market age. Overall, bird performance has been good and at times better for the LED flocks as compared to previous 2 year farm history for participants. This field demonstration has proven the value of LED technology for poultry production; and Phase II of the project, which starts in 2011, will involve the purchase of \$1,000,000 worth of LED bulbs for distribution to qualifying poultry growers by the Resource Conservation District Council.

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Cooperators

Arkansas Resource Conservation District Council

Funding

American Recovery and Reinvestment Act under Department of Energy award DE-EE0000179; University of Arkansas Division of Agriculture

Demonstration of water system sanitation procedures

Issue

Cleaning poultry house drinking water systems continues to be one of the biggest challenges for the industry. These systems, fed primarily by untreated well water containing a variety of naturally occurring contaminants, are often injected with water additives ranging from electrolytes to organic acids. When the water flow is minimal and the temperature elevated, it becomes the recipe for microbial growth which can lead to health challenges that impact grower and company profitability. While the industry recognizes the importance of clean water supplies, they have been at a loss for determining effectiveness of sanitation procedures.

Action

This year our lab began comparing water line swab samples to water line drip samples, both pre- and post-utilization of water line cleaning products.

Impact

Results indicate that swabbing the system is far more effective in determining level of contamination and cleaning effectiveness. This technique has been taken to the field for a local

turkey complex to determine which water sanitation cleaning procedure should be implemented.

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Funding

University of Arkansas Division of Agriculture

Impact of drilling mud on soil chemical properties and plant growth

Issue

Drilling for natural gas deposits in Arkansas has increased during recent years and the environmental impact of land disposal of drilling mud from the drilling operations can adversely impact soil properties and plant growth. Information is needed to determine the amount of drilling mud that can be applied to provide a sustainable method of waste disposal.

Action

A greenhouse study was conducted to assess the impact of amending soil with 0%, 5%, or 10% (w/w) drilling mud on soil chemical properties and plant growth. Results indicate that drilling mud applications of 5% or 10% (w/w) significantly increased soil electrical conductivity, chloride, and sodium levels and reduced growth of bermuda grass and sudan grass.

Impact

Results indicate that excessive application levels of drilling mud can have a negative impact on soil properties and plant growth. Plant species and drilling mud application rates need to be considered when amending soil with drilling mud.

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Funding

University of Arkansas Honors College Undergraduate Research Grant; Bumpers College of Agricultural, Food and Life Sciences Undergraduate Research Grant; University of Arkansas Division of Agriculture

Economic Development and Quality of Life for People and Communities

The role of emotional intelligence and financial well-being on quality of life

Issue

One aspect of emotional intelligence as measured by many assessment tools is the concept of self confidence. For example, David Goleman's skill-based definition of emotional intelligence contends that individuals with "personal competence" have a subject of competence that he calls "self awareness." Self awareness also has several attributes, one of which is "self confidence." Self confidence is defined as "a strong sense of one's self-worth and capabilities."

One area of self confidence is the individual's perception of his or her ability to make sound financial and consumer decisions. There is no standard measure of consumer confidence associated with consumer behavior. The goal was to develop such an instrument using college students in a pilot study in the creation of a consumer confidence scale.

Action

Adapting items from a questionnaire designed for a Canadian consumer survey (Canadian Foundation for Economic Education, 2008), the Consumer Confidence Behavior Scale (CCBS) was developed and used in a pilot study with college students.

The CCBS has 15 items. Each item on the CCBS asks "how confident are you" and was followed by a statement such as "deciding whether or not to rent or buy a home". There were five choices ranging from "not at all confident" to "very confident". The scores were added together and could range from 15 to 75. In the study with 200 college students the mean score was 43.9. Because there is no comparison group, it is not possible to determine whether this was a low, average, or high score.

The next step in the process of improving the CCBS is to determine whether or not it measures one or more dimensions of consumer self confidence. It could measure several ranging from confidence about simple purchases such as house or car to more complex processes such as making investment decisions. Additional data will be collected and factor analysis will be conducted to determine the number of dimensions the CCBS evaluates with college students and community adults.

Impact

This instrument will be disseminated to several other researchers with a common interest in the process of emotional intelligence and consumer behavior. The task is to further refine the evaluation instrument in order that the CCBS can be used with financial educators, counselors, and planners in their task of improving financial behavior of the average American consumer.

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Funding

University of Arkansas Division of Agriculture, AES research support

Preliminary evaluation of septic system absorption field products with differing architectures in a profile-limited soil

Issue

The design criteria for septic system absorption fields in Arkansas uses a progressive approach because it considers soil morphological characteristics as indicators of the soil's ability to transmit and renovate effluent. Largely due to the climate of Arkansas, there are certain design criteria that must be evaluated (i.e., perched seasonal water tables) and it is important to determine if the soil is profile-limited or if the absorption field can be loaded at the state's recommended maximum loading rate. Systems loaded at the state's maximum allowable rate are assumed to eventually be limited by biomat formation rather than soil limitations. However, a significant fraction of Arkansas soils have some profile characteristic that limits their ability to transmit and renovate effluent. Arkansas uses soil morphology as a key indicator of profile limitations, such as perched seasonal water tables, and the current loading rates were developed based on the storage approach (originally calculated using pipe and gravel). Better information is needed on profile-limited soil with actual product lengths more comparable to that used at home sites to determine the effects of alternative products.

Action

A study was initiated in 2008 to evaluate the effects of septic system absorption field product architecture and antecedent moisture condition on in-product storage of effluent and climatic water. Thirteen septic system absorption field products of four differing architectures (i.e., chamber, gravel-less pipe, polystyrene aggregate, and pipe-and-gravel systems) were installed in a profile-limited, Captina silt loam soil (fine-silty, siliceous, active, mesic Typic Fragiudult) and dosed with raw effluent at rates determined by current state regulations via individual peristaltic pumps. Free-solution monitoring ports were installed within each product. The depth to free solution was measured regularly over an 8-month period and used to evaluate product performance.

Impact

Data collected from January through August 2009 indicated that preliminary system performance was not affected by product architecture type. However, statistical differences among individual products were observed during periods of hydrologic stress or wet-soil conditions. All products behaved

similarly under dry-soil conditions (i.e., when the local, seasonal water table was below 91 cm). Surfacing of effluent was not observed for any product and indicated that the current loading rate design method is functioning properly. Though manufacturers of alternative architecture designs have claimed that their products provide more room for effluent storage and call for loading rate allowances, preliminary results do not indicate that a reduction should be granted at this time. Future research is needed to determine the long-term acceptance rates for different architecture types.

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Addressing the recession and the financial crisis

Issue

In 2009/2010 two major economic concerns of University of Arkansas Division of Agriculture clientele were: (1) the recession's economic impact on their farm or business, state and local government or community and families; and (2) the duration of the impact.

Farmers, businesses, financial institutions, and families were concerned about their profitability or financial well being and longer term economic challenges. Local and state government were seeking answers to an array of questions on the economic situation and outlook.

Action

In addressing our clientele's concerns we enhanced our ongoing economic, market, and agricultural outlook and our policy research and educational efforts to provide an enhanced understanding of the economic and policy realities caused by the ongoing financial crisis. This information was then brought together to give our clientele a big picture perspective of the economy, markets, and agricultural outlook. This allowed us in real-time to speak to a broad set of issues impacting producers and businessmen, state and local governments and families.

We spoke one-on-one, at group, producer, and state meetings. We delivered at the 2010 Arkansas Rural Development Conference a presentation titled "Economic Outlook Considerations for Rural Arkansas". We spoke twice on "Economic Outlook Considerations" to a joint meeting of the Arkansas House and Senate Committee on City, County, and Local Affairs. We provided a keynote speech to the Arkansas Bankers Association's Agri Conference titled "Big Picture Perspective: The Economy and Market Outlook." We spoke at the Mid-Year Board of Directors Mississippi Delta Council Aquaculture/

Farm Policy Joint Committee Meeting on "Factors Impacting, Trends, and Commodity Market Outlook." At the National Rice Industry Outlook Conference we discussed "Arkansas' Rice Situation and Economic Outlook."

In order to provide the most current economic, market, and agricultural outlook information to a broader array of clientele we enhanced our Web and social delivery of economic, market, and agricultural outlook and policy information.

Impact

We were and are today able to provide our clientele in real time with insight, perspective and considerations about the economic and monetary setting, markets, and agricultural outlook. We achieved these results at the national, state, local, and producer levels as previously discussed. Our economic, market, and agricultural outlook and policy Web delivery traffic averaged over 10,000 per month.

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Impact of consumer perceptions on the demand for organic foods at farmers' markets

Issue

Growth in sales of organic and all natural foods have been increasing at an astonishing 3 to 7 times the growth of every other conventional food category. Organic food and beverage sales represented approximately 4% of overall food and beverage sales in 2009 according to the Organic Trade Association's 2010 Organic Industry Survey. According to this same survey, U.S. sales of organic foods have grown from \$1 billion in 1990 to almost \$25 billion in 2009. Reports from the literature have shown that consumers perceive organic foods are safer because they don't contain "harmful chemicals" and are more nutritious and higher quality than their conventional counterparts. Administrators of farmers' markets in Arkansas were interested in whether shoppers at their markets would be interested in purchasing organic foods at their farmers' markets.

Action

To answer this question, we surveyed more than 300 consumers at three farmers' market locations in Northwest Arkansas: Fayetteville, Springdale and Eureka Springs. Only 42% of those surveyed purchased most of their organic foods at farmers' markets, and 80% surveyed answered "yes" that they would buy more organic if its price was similar to that of conventional foods. We also surveyed these shoppers as to their concerns and beliefs about safer foods. The largest category (36%) said their major reason for shopping at farmers' markets was that they wanted their food to be free from chemicals, with pesticides being the biggest safety concern of 45% of the respondents. Only 2-6% of respondents were concerned about presence of harmful bacteria on their food. An overwhelming majority of the respondents (76%) believed that organic foods are inherently safer than conventional. We repeated these surveys with consumers at three metropolitan farmers markets

in Little Rock, Hot Springs and Texarkana. A majority of these shoppers (71%) also believed organic foods were safer than conventional foods. Surprisingly, three times as many patrons in southern Arkansas were more concerned about harmful bacteria in conventional foods than in organic. The number one reason for shopping at farmers' markets was to support local farmers.

Impact

Clearly, there is a considerable individual difference among perception and the potential for food safety problems. Therefore, an immediate need exists to develop applicable interventions for organic food and poultry processing.

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Impact of the macroeconomy on production agriculture and agribusiness

Issue

Every year producers and businesses in Arkansas must make plans for the future based on the potential demand for their products and the costs of production. These needs generate a strong demand for knowledge about the current and projected state of the macroeconomy. Businesses are interested in knowing what will be happening to aggregate demand for goods and services and this is strongly related to projecting national income. Given that many Arkansas agricultural products are sold abroad, anticipated changes in exchange rates are of keen interest. Costs are reflected in wage levels, fuel prices, interest rates and land prices.

Action

Data are collected from several sources to be used in constructing projections for the various aspects of the macroeconomy that affect agriculture and agribusiness. The Economic Research Service, an agency of the United States Department of Agriculture, provides annual, updated forecasts for the agricultural sector for the next ten years. This provides data for many of the key aspects of input costs for agriculture. The projections also provide historical and projected farm incomes which are useful in assessing the health and viability of agriculture. Data are also collected from the Bureau of Economic Analysis (Department of Commerce), Bureau of Labor Statistics (Department of Labor) and the Federal Reserve System, and the National Agricultural Statistics Service.

Impact

The economic data and projections are presented along with informed opinion on the likely path of economic activity in the coming year in the *Farm Management and Marketing Newsletter* and as a keynote address to the 2010 Arkansas

Bankers Association Agri Conference attended by approximately 70 bankers and industry representatives. The Newsletter is published by the Cooperative Extension Service, University of Arkansas, Division of Agriculture, and is widely read. It had 8746 hits in calendar year 2010. The article and presentation provide analysis that is useful in multiple ways. Almost all business planning and activity is based on economic projections. Furthermore, much macroeconomic behavior is driven by government decisions, particularly at the federal level. The analysis provides useful reference points for evaluating proposed policies.

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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 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 rapid emergence of rural communities becoming new destinations for Latino migrants), the magnitude and impacts on the social and environmental dimensions are not well understood. Rural leaders, policy makers and planners have a clear need for timely demographic and sociological data 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. and to assess the social and demographic antecedents of land cover change. Earlier research discerned 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. Over 170 immigrant entrepreneurs and over 30 key informants in 59 communities in 26 counties in rural and urban western Arkansas were interviewed. Data from these interviews are being analyzed. A related project is underway to assess the demographic, social, and geophysical antecedents to land cover change on areas immediately adjacent to the boundaries of the Buffalo National River in Northern Arkan-

sas. 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 long-standing 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 and the emergence of an important “entrepreneur class” within the migrant community. This newly formed reservoir of human capital holds the potential to serve as a 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 recognition that rural areas have limited resources compared to urban areas for assisting in the adaptation and assimilation of new residents is crucial. Outreach products and programs to encourage and support local business formation in rural communities have been initiated. 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.

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A case study of a culinary tourism campaign in Germany: implications for strategy-making and successful implementation

Issue

Tourism organizations are recognizing the potential of culinary tourism as a powerful tool to promote destinations. Despite the growing interest in this as a field of study and as a way to promote a tourism destination, the knowledge about how to successfully develop and implement a culinary tourism

strategy is limited. The objective of this case study is to explore the key issues in the strategic process of a culinary tourism campaign based on a recently introduced initiative in South Germany.

Action

Data collection took place in person at the participants’ place of business; each interview took about 90 to 150 minutes. Based on the literature review and grounded in a strategic process framework, interview protocols were developed and tested during the pilot case study. The case study involved four informants from a region of Europe known for quality culinary activities and initiatives. Based on this process, the final version of the protocol used in this study underwent minor revisions. The researchers conducted semi-structured interviews with the participants following a defined protocol. While the protocol provided guidelines for the data collection process, the researchers remained open to additional issues emerging from the interview. The overriding purpose of the interview was to identify the strategic process used by developers of culinary tourism initiatives. Both authors were present at each interview; in addition to the researchers’ notes, the interviews were recorded upon approval of the participants. The recorded interviews were transcribed shortly after they occurred.

Impact

Six key areas emerged that were associated with culinary tourism success: 1) the strategy itself, 2) cooperation among stakeholders, 3) leadership issues, 4) culinary profile promotion, 5) communication of quality, and 6) enhancing tourist perceptions. The implications of this study highlight some of the differences in “what is” and “what should be” for regional initiatives.

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Generation Y consumers: key restaurant attributes impacting positive and negative experiences

Issue

Satisfying customers is one of restaurant managers’ and owners’ main goals; however, there is no clear-cut formula to achieve this. While numerous studies and methods have been used to test customer satisfaction in foodservice settings, there is no overall consensus on what is the best indicator—food quality, atmosphere, or service quality. As with other service environments, customer satisfaction in the restaurant industry is of critical importance, as 90% of unsatisfied customers never return to a dining establishment. This finding highlights the close connection between customer satisfaction and the

longevity and financial success of a restaurant. The objective of this study is designed to test drivers of positive and negative experiences throughout the restaurant industry that lead to customer satisfaction or dissatisfaction. In particular, the study focuses on the young diner market segment across three restaurant sectors. For this study, the young diner segment is defined as consumers that fall in the Generation Y category (ages between 16 to 34 at the time of this study).

Action

To assess restaurant selection factors, the study uses a descriptive survey methodology. Following the data collection methods used by earlier authors in this area, respondents were contacted through a convenience procedure. The participants in this study were asked if they would be willing to voluntarily complete the survey. If they answered in the affirmative, an anonymous survey was completed. If not, no survey was completed. The data collection period resulted in 574 total responses. The data were collected from one metropolitan area in the southwestern U.S. Participants were contacted at predetermined locations: shopping malls and local attractions.

Impact

This article will be published in an upcoming issue of the *Journal of Hospitality & Tourism Research*. While the results were fairly consistent with what was found in the literature, the frequency and relative importance of consumer needs depend on the restaurant segment and its targeted demographic group. Overall, young customers want the same things that more mature customers want: fast service, friendly service, good quality food and an overall positive dining experience. But, the value placed on these attributes varies as key drivers for positive and negative experiences. Further, these perceptions and the importance of a variety of attributes varied based on restaurant segment. Thus, while there will never be a clear-cut formula to satisfy all age demographics and restaurant segments, operators that focus efforts on key drivers of positive and negative restaurant experiences for their restaurant segment are sure to better satisfy Generation Y consumers as a target market.

The most common elements driving negative experiences of Generation Y consumers are within operators' control. The attraction and retention of this demographic group requires an assurance that a bundle of activities are effectively executed and that on-going communication with customers is facilitated to recover from any failures that may occur. Overall, the key bundle of activities driving negative experiences for this age group include quality of service, speed of service, quality of food or drink, friendliness of staff, and cleanliness of the restaurant. Follow-up with staff and patrons on these key issues during the service encounter will likely have substantial benefits in the form of young consumer satisfaction and retention.

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Fine dining restaurant selection: direct and moderating effects of customer attributes

Issue

This study examined the relationship among six restaurant attribute factors and three consumer characteristics/behaviors in fine dining restaurant choice selections. The six factors are described as promotion, price/value, quality expectation, setting, dietary and variety/innovative characteristics. Gender, age and dining frequency were shown to impact the strength of the relationship with these six factors.

Action

Fine dining was defined as establishments where an average check is \$40 or more per person. The survey included 17 items (with a 5-point scale, 1 = not important and 5 = very important) that were determined by the authors as potentially important selection factors based on the literature review and a focus group discussion on key selection factors. Because our study looked at higher end dining situations, we also included items shown to be important for success in high-end restaurant settings such as ratings in food guides, variety of menu, and innovative menu items. This methodology allows us to report results based on overall factors as well as to differentiate key factors across diners based on age, gender, and dining frequency.

Impact

The findings will be published in an issue of the *Journal of Foodservice Business Research*. The results of this study provide some valuable information for practitioners and future research. Specifically, practitioners should consider key target market characteristics to ensure a fit between restaurant attributes and expectations of targeted customers. The findings also provide support for the need for researchers to evaluate and control for key customer characteristics in service encounter research. Age, gender and dining frequency proved to be important variables in this regard. It should be noted that restaurant operators need to identify the attributes (benefits) important to diners, but it is the classification variables which allow companies to better identify and reach these consumers.

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Strategic management: An analysis of its representation and focus in recent hospitality research

Issue

This study addressed the following questions: What is the

frequency of articles related to the topic of strategy in recent hospitality journals? How does the content of these articles differ from the more general field of strategic management? And, what are potential gaps where researchers in the hospitality field can make contributions?

Action

This study looked at the number and percentage of strategy-related articles published in leading hospitality journals for 2005 through 2009. The determination of the percentage of strategy-related articles published and categorizing these articles by key strategy topic area required several steps: 1) defining strategic management as an academic area within hospitality; 2) determining key strategy topic areas and key words or terms; and 3) defining characteristics of the hospitality field that may impact what is and what is not strategic management in hospitality. Hospitality journal articles were then coded as strategy-related or other, and (if determined to be strategy-related) the articles were categorized into one of ten key topic areas.

Impact

Overall strategy articles represent about 27% of the total journal articles from the 5-year period. In comparing hospitality journals to the sole top-tier business journal focusing on strategy, this study indicates differences exist between key topic areas of focus. These differences seem to indicate that researchers in general strategic management tend to focus on less applied and more theoretical notions of strategy where researchers in hospitality strategic management tend to focus on more tactical methods when addressing questions of strategy.

The importance of strategic management and strategic thinking in hospitality and hospitality research has never been greater. With increasing turbulence in the global environment, the field of hospitality (and its related research) must assess and provide strategic approaches to address challenges and opportunities for the future. The value of this study is in providing an overview of what has been studied in hospitality strategy in the recent past and pointing out future research opportunities for hospitality strategic management issues. The complete results of this study will be published in the *International Journal of Contemporary Hospitality Management* (2011).

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Innovative versus incremental new services: different strategies for achieving success

Issue

Should managers have a different approach for the development of very innovative new services from that of incremental

new services? Innovativeness is linked to levels of risk, ambiguity, necessary resources and complexity, and thus it is suggested that firms should have different priorities and strategies when developing new products and services.

Action

Based on a large-scale survey, this study focused on new hotel innovation projects in an attempt to gain insight into the impact of level of innovativeness on the factors that are linked to new service success and failure. Specifically, this study surveyed 183 firms who recently implemented innovation projects and considered 4 primary factors associated with new services development (NSD): service product, market, process, and organization.

Impact

The findings were published in the 2010 *Journal of Services Marketing*, Vol. 24, Issue 1, pages 3-15. The research results suggest that there are two global success factors regardless of their degree of newness—market attractiveness and strategic human resource management. Several other factors, however, were found to influence the outcome of incremental projects, such as: service advantage, empowerment, training of employees, behaviour-based evaluation, tangible quality and marketing synergy. For very innovative new hotel services, market responsiveness and pre-launch activities were found to be related to success. Results from this study provide evidence of substantial differences between these two innovation categories and implementation in a service environment. Managers who design new service development processes that are tied to the key success features in innovative or incremental NSD increase the likelihood of success.

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Perceived match of wine, cheese and the impact of additional food elements: a preliminary study

Issue

While the enjoyment of wine and cheese cannot be denied, few scientific studies have been completed to assess the relationship among cheese type, wine type and the impact on the sensation of match. While the number of studies in general food and wine or cheese and wine are limited, there have been no studies published that consider the change in perceived match of cheese and wine when other food elements are added to the mix. Therefore, the main objectives of this exploratory study are to generate greater scientific knowledge regarding wine and cheese pairing as well as the potential impact of additional food items to the wine and cheese combination. The results of this research will provide valuable information for

wine and foodservice professionals in the selection of ideal matches in cheese, wine and other food elements that can be used to enhance a cheese and wine combination.

Action

A group of industry professionals attending a wine educators' conference participated in this study. Specifically, the group attended a wine and cheese seminar as part of a 3-day conference (N = 14). Participants included sommeliers, wine distribution representatives, and wine educators. Participants used both sequential and mixed tasting assessments (1] wine only, 2] cheese only, 3] wine and cheese combined, and 4] wine, cheese and additional food item). A further objective was to consider the impact of additional food elements to the recommended wine and cheese matches. To evaluate the impact, the study used three food items as additional elements for four of the six wine and cheese pairings.

Impact

The findings of this study will be published in an upcoming issue of the *Journal of Foodservice Business Research*. The general wine and cheese findings support earlier studies in several areas. For the most part, the expert recommendations for ideal matches of the wine and cheeses matched the perceptions of the industry professionals in this study. As with earlier studies, this study found substantial differences in perceptions across the participants. This finding supports current arguments on individual differences in sensory perception based on sensory sensitivity as well as possible psychological impacts. The concept of finding an ideal match for the average consumer may need to be based on a conversation about what types of foods or drinks they generally like to determine likely sensitivities and tolerance levels for certain tastes or flavors. Food and drink service professionals with this ability are likely to have a substantial advantage for making a synergistic pairing for individual guests.

The addition of specific food items to wine and cheese pairings added an increase in the overall sensation of match. This finding highlights the value of layering flavors, fruit, acid, sweet contrasts, and spice to improve wine and cheese relationships. Given the exploratory nature of the approach used in the study, this positive finding represents an important gap in the literature requiring additional exploration. Pulling back the "veil" of wine, cheese and food relationships may require new approaches to assess important implications for the field. Typical research methods in most lab settings provide better control over a variety of threats to validity. But, these results may not be generalizable to field settings. Therefore, the creation of research centers that bridge this gap between the lab and the field appear crucial to move this research stream forward.

For wine and foodservice professionals, the study highlights the need to understand both likely wine and cheese matches and individual preferences of consumers. Additionally, the findings point to the potential enhancement of ideal matches in cheese and wine with the addition of other food elements that add layers of flavors and contrast.

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Culinary tourism – a case study of the gastronomic capital

Issue

France maintains an important position as a traditional destination for quality food and wine. It seems that most gastronomic books have a focus on French traditions of food and wine. In France, top quality gastronomy is a substantial aspect of national identity that expresses national culture. A great example illustrating the importance of cuisine in France is the much repeated quote of the late French President Charles de Gaulle: "Nobody can simply bring together a country that has 265 cheeses." For the French, cheese is more than just a product; it also represents a region's geography, climate, history, culture, and cuisine.

While much has been written about the importance of cuisine in France, very little is known about the impact of the gastronomy-tourism market segment and the importance of gastronomy tourism as a key promotional strategy in a locale with strong traditions of gastronomy. Therefore, this case study considers the relationship between culinary tourism and the tourism strategy for Lyon and the Rhône-Alpes region. Specifically, this study uses a case-study approach to assess the importance of culinary tourism, unique characteristics of culinary tourism products, culinary tourism initiatives, and key issues for implementation in the Rhône-Alpes region.

Action

To investigate the role of culinary tourism in a traditionally defined region, we used a qualitative approach using a case study of Lyon and the Rhône-Alpes region. A qualitative approach was considered appropriate as it will add 'flesh and bones' to the topic through a closer explanation of culinary tourism and its processes. This geographic area represents an 'extreme case' to assess the role of culinary tourism. By selecting an extreme case, we are able to better understand the role of culinary tourism with implications on how this model might be successfully adapted to other regions. While Paris is the capital of France and famous for its food, Lyon is believed to be the French capital of gastronomy. Lyon is not only considered to be 'France's gastronomic star', but also the 'gastronomic capital of the world'. Given the aim of the study, a purposive sampling approach was used. Multiple informants that were responsible for the development, marketing and operations components of culinary tourism products were included in this purposive sampling. The interview was organized around pre-defined themes that included the importance of culinary tourism, unique characteristics of culinary tourism products, promotion success, successful culinary tourism ini-

tatives, and key issues for implementation. Additional assessment was completed through document review and archival analysis (i.e. published promotional documents).

Impact

The findings of this study were published in a 2010 issue of the *Journal of Culinary Science & Technology*, Vol. 8, Issue 1, pages 14-32. As described by one interviewee, the role of culinary tourism appears to be a yes and no proposition in Lyon and the Rhône-Alpes region. Clearly, the region has an established image as a gastronomy center. This image is built on the clear identity of the traditional foods and wines from the region. This strong identity is solidified in this setting through structured programs providing geographic indicators and quality standards to maintain a clear sense of place and terroir. This identity and terroir concept support two of the criteria for competitive advantage: a sense of rarity and an inability to completely copy the experience outside of the place attachment.

This identity translates into the touristic terroir that defines the bundle of activities available to travelers in this region. Current trends indicate that tourism in this traditionally strong culinary region is driven more by sports activities, historic sites and attracting congresses as primary drivers. The culinary factor appears to be a secondary driver due to a mature culinary location and increased competition reducing the non-substitutable criterion for competitive advantage.

Still, the culinary tourism market segment appears to be a key factor in creating return visits, according to our informants. Therefore, the culinary tourism products appear to be valued by many consumers either as part of the bundle during the initial travel decision or as an important and valuable factor for returning to a location.

From a strategic perspective, the region appears to have a clear strategy with a clearly differentiated image and identity. This identity and the culinary activities appear to be built on experiential involvement and place attachment; thus, the strategy seems to support the importance of these two constructs in tandem.

The study of Lyon as a longstanding leader as the gastronomy capital and the recent emergence of the Beaujolais region as an important wine tourism location appears to highlight the impact of life cycle on tourism strategy. One implication of this approach is a consideration for micro and macro assessments of the definition of product. From a macro view, Lyon and the Rhône-Alpes region appear to show many signs of maturity in its culinary tourism product – a higher degree of product diversification (the emergence of the Beaujolais region and other regions following suit as new and improved wine tourism products), greater market segmentation (e.g., sports enthusiasts, nature lovers and historic city seekers as part of the culinary tourism market), and greater differentiation (Halles de Lyon as a gastronomic center, haute cuisine and more casual dining opportunities defined by place and involvement). Based on the above definitions, it could also be argued that there are signs that the traditional product is in the decline stage (e.g., buyer loyalty and a declining importance of advertising based on a longstanding image). A connection could also be made to the seminal life cycle concept by the Boston Consulting Group

of products ranging from question marks, stars, cash cows, and dogs. In this situation, bouchons may serve as cash cows and other emerging areas such as the Beaujolais model as a star for the region.

The life cycle concept has long been held as a fundamental variable in determining an appropriate business strategy as well as important in considering major changes to business strategy due to changes in life cycle stages. The findings in this study and the relationship to the life cycle concept have important implications for the promotion of culinary tourism and research in the area.

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Quick service restaurant choice: key restaurant attributes and the role of gender, age and dining frequency

Issue

Practitioners involved in the quick service restaurant (QSR) concept planning and operations management need research-based protocols to evaluate and control key customer variables in service encounter research.

Action

To assess restaurant selection factors, the authors used a survey methodology and collected 784 completed surveys from respondents. This methodology allowed the authors to report results based on overall factors as well as to differentiate key factors across diners based on age, gender and dining frequency.

Seven attribute factors (quality indicators, setting, marketing, price/value indicators, dietary considerations, access issues and special promotion) explained nearly 60% of the total variance in responses by participants in this study. The results provide important implications for QSR planning and operations with 1) a top ten list of individual attributes defined as very important across the participants in this study, 2) seven attribute factors that explained a substantial portion of the variance in decision factors across the study's sample and 3) key differences in the importance of these factors by targeted groups based on age, gender or dining frequency.

Impact

The results of this study provide evidence in support of previous research and confirm some of the lay hypotheses held by restaurateurs. The importance of key attributes in general and the variety of benefits related to key consumer characteristics for QSRs provides substantial managerial direction for resource allocation decisions in the field. A conspicuous contribution of this paper (furthering the study of QSR attributes) is that the findings suggest vital areas to address in

concept development and ongoing QSR operations. Matching the consumers' bundle of key benefits with the appropriate resource provision provides an opportunity to maximize value for the guest, as suggested in the discussion.

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Improvements in training and educational opportunities for pest management professionals

Issue

There is a continuing need to provide quality education and materials to pest management professionals that provide commercial services to the Arkansas public. These individuals are certified through the Arkansas State Plant Board through training and educational materials produced and maintained by the Extension urban entomology program. All individuals seeking certification as a commercial or non-commercial pesticide applicator must attain a level of expertise that enables them to pass the subject exams in their desired certification area. Certification areas include: termite and structural pest control; household pest and rodent control; food manufacturing, processing, and storage pest control; general fumigation; food related fumigation; ornamental, tree, and turf pest control; weed control; and golf course pest control. Through the efforts of the Extension urban entomology program, up-to-date training and educational materials are made available for use in training.

Action

A total of 405 individuals received recertification education—243 licensed structural pest control operators and 162 licensed ornamental pest control operators. The Extension urban entomology program also has responded to the request of the Arkansas Pest Management Association to provide training through workshops and presentations at their annual meeting.

Impact

The training materials help assure that commercial pesticide licensees in Arkansas are up to date in their knowledge, thus ensuring that Arkansas citizens are dealing with certified professionals.

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Funding

University of Arkansas Division of Agriculture

Irrigation power unit performance, efficiency, and NO_x emissions with petroleum diesel, biodiesel, and biodiesel blends

Issue

Arkansas ranks number four in the U.S. in both irrigated crop acreage (4.5 M acres) and number of irrigation pumps (41,089). Approximately 61% of Arkansas irrigation pumps are powered by diesel engines. Given price volatility and concerns about the long-term sustainability of petroleum supplies, there is renewed interest in fueling diesel engines, including irrigation power units, with biodiesel and biodiesel blends. Research is needed to determine if irrigation power units fueled with biodiesel differ in performance, fuel efficiency, and emissions of nitrogen oxides (NO_x).

Action

Division of agriculture researchers cooperated with FutureFuel Chemical Company (Batesville, Ark.) and Engines, Inc. (Jonesboro, Ark.) to compare performance, fuel efficiency, and NO_x emissions of a 67-kW irrigation power unit fueled with No. 2 ULSD petroleum diesel (D2), a 20% biodiesel blend (B20), a 50% biodiesel blend (B50), and neat biodiesel (B100) at rated engine speed (2400 rpm) and at typical pumping speed (1800 rpm). At rated speed, there were no differences between D2 and B20 in engine torque, power, or brake specific fuel consumption. There were no differences between the four fuels in thermal efficiency or brake specific NO_x emissions. At 1800 rpm, there were no differences between D2 and B20 in engine power or torque; however, torque and power decreased with B50 and B100. Brake specific fuel consumption increased as the percentage of biodiesel increased, but there was no difference between the four fuels in thermal efficiency. Finally, there was no difference between D2 and the biodiesel blends or neat biodiesel in brake specific NO_x emissions.

Impact

The results of this study indicate that a typical irrigation power unit performs equally well and produces similar NO_x emissions when fueled with D2 or a B20 biodiesel blend. However, specific fuel consumption increases approximately 3% when fueling with B20. Fueling with B50 or B100 results in both decreased engine power performance and increased specific fuel consumption relative to D2 or B20. Finally, there were no differences in specific NO_x emissions by fuel. Based on these results, B20 is recommended as the optimal biodiesel blend for this and similar irrigation pumps.

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Arkansas Soybean Promotion Board; Engines, Inc.; FutureFuel

Chemical Co.; University of Arkansas Division of Agriculture, Arkansas Agricultural Experiment Station.

Imported fire ant research and education

Issue

Imported red fire ants and imported black fire ants are pests that affect agriculture, natural environments, and recreational, residential and public areas. The annual economic loss in Arkansas is estimated to be \$1.28 million, with the greatest losses in residential households, electrical and communication equipment, agriculture, golf courses and schools. Imported fire ants (IFAs) now infest over 320 million acres in the southern U.S., from Virginia to California. Fifty-eight of Arkansas' counties are infested with IFAs, and 35 counties are included in the federal imported fire ant quarantine.

Action

The Extension urban entomology fire ant program includes biological control, applied insecticide studies and public education. Parasitic phorid flies, which specifically attack fire ants, have been released since 2002, with the most recent release in 2010 of *Pseudacteon curvatus* in Pulaski County. We evaluated new products for efficacy in urban and agriculture situations including commercial sod production. Arkansas producers grow about 9,000 acres of sod each year, most of which is grown in quarantined counties. Educational efforts include supporting extension faculty needs, educating Arkansas residents and on-line education (such as eXtension). We also developed a fire ant Integrated Pest Management (IPM) non-credit course for the IPM training consortium. This course is unique in that in it includes an assessment and provides continuing education credits to students that complete the course. Finally, the Division of Agriculture hosted the 2010 Imported Fire Ant and Invasive Ant Conference in Little Rock, which included more than 100 participants from as far away as Australia.

Impact

Research from 2010 showed that phorid flies are established in 18 Arkansas counties. We demonstrated that insect growth regulators used against fire ants could negatively affect the phorid flies developing in fire ants. The rapid spread and establishment of *Pseudacteon curvatus* in Arkansas will allow future releases to concentrate on another species, *Pseudacteon obtusus*, which has a preference for larger fire ant workers. Results from sod studies suggested that combination treatments with baits and bifenthrin may be suitable for quarantine treatment of commercial sod, which is less expensive (\$64.00/acre) than the current treatment costing approximately \$600/acre.

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Funding

USDA APHIS; Southern Regional IPM Center; BASF; Bayer Environmental Sciences; Central Life Sciences; Dupont; Syngenta; University of Arkansas Division of Agriculture

Potential vectors of dog heartworm (*Dirofilaria immitis*) in northeast Arkansas

Issue

Dirofilaria immitis is a mosquito-borne filarial worm and is the causative agent for canine heartworm disease in the United States and throughout the world. Vectors of *Dirofilaria* vary according to geographic region. In the southeastern United States, few studies have been conducted on the potential vectors of *D. immitis*. The majority of studies that have examined the potential for mosquitoes to harbor *D. immitis* in the United States date back to the 1960-70s when microscopy was the only technique used to determine if mosquitoes harbor filarial larvae. The disadvantages to using microscopy to identify potential vectors are: 1) it is time consuming; 2) only a small number of mosquitoes can be dissected; and 3) it is difficult to morphologically determine microfilarial larvae to species. With the advent of new molecular techniques, a rapid identification of *D. immitis* infection can be determined in mosquitoes using polymerase chain reaction (PCR).

Action

A study was conducted to determine the principle mosquito vector(s) of *D. immitis* and their prevalence. Mosquitoes were collected in the Jonesboro, Ark. area from 25 April to 19 October 2009 using the New Standard Miniature Blacklight UV Trap. Traps were placed out on a weekly basis, weather permitting. Mosquitoes were also collected from the kennel of a positive dog. Mosquitoes were examined for *D. immitis* using molecular techniques.

Impact

This is the first study to provide information on the seasonal distribution of dog heartworm in mosquitoes in northeast Arkansas. This data will provide information to help veterinary practitioners to more accurately determine when mosquitoes are more prone to harbor *D. immitis* and potentially transmit this nematode. A total of 13 mosquitoes were tested for *D. immitis*, of which 9 were found to be positive. They included: *Ae. vexans*, *An. punctipennis*, *An. quadrimaculatus*, *Cx. pipiens*, *Cx. erraticus*, *Culiseta inornata*, *Ps. columbiae*, *Ps. ferox* and *Ps. howardii*. Of the 1,204 mosquito pools tested, 7.4% were positive for *D. immitis*. When mosquitoes were collected inside the kennel of a positive heartworm dog, 73.7% were positive for *D. immitis*. These percentages are extremely high, and should bring awareness to owners or facilities with multiple dogs (i.e., dog shelters, training facilities). If a positive dog is on the premises and exposed to mosquitoes, the other dogs in the kennel should be immediately removed and protected from being bitten by the mosquitoes that may have had a blood meal from the positive dog.

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Novartis Animal Health; University of Arkansas Division of Agriculture

An examination of nematode and trichomycete associations in larval mosquitoes

Issue

Mosquitoes are widely recognized as nuisance pests. They not only contribute to a decreased quality of life, but they can pose a public health risk since they are vectors of disease pathogens such as malaria, yellow fever, encephalitis, West Nile and dog heartworm. The buildup of resistance to chemical controls, the potential for health risks due to insecticides, and reduced efficacy of many chemical formulations has pushed research into exploring safer and alternative methods of mosquito control, such as biological control. A number of mosquito/biological control strategies have been examined including nematode and trichomycete associations which can result in death of larval mosquitoes. There are no published data on nematode and trichomycete fungi associations with mosquito larvae in Arkansas.

Action

A survey is being conducted to examine the nematode and trichomycete associations with mosquito larvae in natural and artificial habitats. In 2010, the larvae of ten mosquito species were collected and examined for associations, with 3.0% of larvae infected with trichomycetes. No nematodes were discovered. This survey will be continued in summer 2011.

Impact

This study will result in a thorough list of nematode and trichomycete associations in northeast Arkansas. Knowledge of these symbiotic associations may provide new tools to be developed to help control mosquitoes in Arkansas.

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University of Arkansas Division of Agriculture

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 primary objective of the IFSE Center for Food Processing and Engineering is to facilitate research leading to value-added products and improving the efficiency and effectiveness of the processing of agricultural products. The Center for Food Safety seeks to maintain or improve the safety of foods through production, harvest, processing, distribution and storage. The Center for Human Nutrition and Functional Foods seeks to enhance the availability of important phytochemicals in foods, and promote 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 research projects, in addition to general research in eleven major research program areas, partnering with 201 companies from 36 states and eight foreign countries, resulting in 380 journal articles and 24 other research/Extension publications by affiliated scientists.

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. Rice processors are gaining new understanding of factors that affect yield and quality of processed rice products. Other major program areas are processing of vegetables and fruits, value-added grape and berry 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. The Sensory Service Center provided descriptive analysis work or consumer evaluations for fourteen national companies as well as internal researchers. Completed sponsored projects in the area of vegetable processing provide industry with millions of dollars of increased returns annually. A private company, using a process developed by IFSE and others, produces carbon and sodium silicate from rice hull ash. The

environmentally friendly process provides millions of dollars from sale of the products while reducing the rice processing waste stream. Patented, commercialized vineyard mechanization systems provide significant labor cost reductions while maintaining or improving yield and fruit quality. The ability to manage yield through “balanced cropping” may prove even more valuable.

University of Arkansas 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.

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French Camp Vineyards, Santa Margarita, California; Institute for Continental Climate Viticulture and Enology, Columbia, Missouri; Arkansas Children’s Hospital, Little Rock, Arkansas; University of Ghent, Belgium

Funding

USDA Special Grants; Multiple Industry Grants; University of Arkansas Division of Agriculture

Training in experimental auctions

Issue

Experimental auctions have become a popular tool used by applied economists to elicit people’s willingness to pay (WTP) for certain goods due to their demand revealing properties. While some subjects may be familiar with the structure of an English auction, they most likely have never participated in a Vickrey auction or a Becker-DeGroot-Marshack mechanism typically used in experimental auctions. This is the reason why most experimenters employ a training phase that precedes the actual valuation task. The purpose of any training procedure should then be to clear out any misconceptions about the mechanism that would prevent elicitation of true homegrown values and/or prevent strategic manipulation. There is however no widely accepted training procedure used when conducting experimental auctions.

Action

A research team tried to assess the effect of training on bidding behavior of subjects that participate in experimental auctions. They used a 2nd price Vickrey auction, a commonly used elicitation mechanism, to assess valuation for a number of products with varying expected payoffs. They found that bid values of subjects given extensive training are higher than those of subjects given only minimal training prior to the actual auctions. This finding implies that extensive training tends to increase WTP values. This also implies that subjects who are not well trained are likely to underreport their WTP.

Impact

Their findings imply that extensive training could elicit

more accurate WTP values from subjects in experimental auctions. This finding has significant importance since it implies that researchers should devote considerable time to training subjects in economic experiments. An alternative approach they suggested is to use a series of training experiments in induced value settings to give subjects a chance to learn about the incentive compatible properties of the auction mechanism. Experimental auctions are now popularly used to provide information about consumers’ valuation for new food products, technologies, and information, which are then used for important pricing and product adoption decisions and policy analysis.

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University of Arkansas Division of Agriculture

The relationship among participative management style, strategy implementation success, and financial performance in the foodservice industry

Issue

Food service industry managers have been shown to prefer directive management styles due to time constraints and ease of decision-making. However, research has documented many benefits of the participative management style as a method for increasing information processing, utilizing knowledge dispersed across the organization, providing more alternatives, facilitating opportunity recognition, and assuring that good ideas are not overlooked.

Action

The study used survey methodology and a random sample of members in a U.S. state restaurant association to study 1) the relationship among organizational structure, involvement by top management, middle management, lower management and frontline employees on firm performance; and 2) when controlling for firm size and industry segment membership, the relationship among direct involvement effects and interacting involvement effects on performance.

Impact

The study confirmed that higher top-management participative management style in decision-making and in the strategy implementation process is important to enhance financial performance and strategy implementation success regardless of firm size. The interaction of participation by all levels of the firm is a useful approach to increase the likelihood of strategy implementation success. Top management and frontline employee participation are critical organizational levels for enhancing participative management approaches and ultimately increasing financial performance for all foodservice firms.

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University of Arkansas Division of Agriculture

Risk management education for specialty crop producers

Issue

Local food marketing has expanded beyond the farmers' markets and food stands. Through local and regional supply networks, farmers are gaining access to customers in new and innovative ways. Local farmers are marketing directly to public schools, hospitals, and institutions of higher education as well as directly to food retailers. One group of resources gaining popularity are electronic marketing networks that gather information from producers and potential customers and give farmers greater access to local and regional markets. Large retail chains are now exploring how electronic markets can be used to increase consumer market share by meeting customer demands for fresher, locally grown foods. These new and emerging direct markets potentially offer benefits to producers by providing known and stable markets. The goal of this project was to develop a risk management education program for specialty crop producers in Arkansas interested in direct marketing of their products.

Action

The risk management needs of specialty agriculture producers, particularly related to marketing and legal issues, were assessed. Based on the information gained, two sets of materials were produced. First a guide book containing 62 materials in English and 44 in Spanish related to financial, marketing, production and legal risk management was developed for use by agricultural producers engaged in (or considering) direct marketing of their products. Second a 21-lesson train-the-trainer curriculum was developed for risk management educators interested in providing legal, financial and marketing risk management education to their clientele. All materials are available in hardcopy, on CD and on our website, www.manageyourrisk.net.

Impact

These materials have been distributed to over 400 producers, extension agents and non-profit educational organizations in the last year.

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Funding

USDA RMA; USDA CSREES; SRRMEC; the Wal-Mart Foundation; University of Arkansas Division of Agriculture

Economic contributions of the 2008 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 non-agricultural 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, animal agriculture and forestry) on value added, employment and wage income was estimated for 2008, which was the latest year for which sufficient data are available. Agriculture is responsible for the creation of 261,101 jobs, or 16.6% of the state's jobs, \$9.6B or 15.6% of the state labor income and \$16.3B or 17.0% 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 Trade, Real Estate and Rental, and Transportation and Warehousing. Individually, the crop, animal agriculture and forestry sectors provide the catalyst for the direct creation of \$3.3B, \$2.6B and \$2.6B, respectively, in value added and 56,051 crop sector jobs, 57,601 animal agriculture sector jobs and 34,065 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 Gross Domestic Product by State 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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Factors affecting Arkansas's agritourism operations

Issue

Agritourism is a growing segment of the agricultural enterprise. However, there is limited information available to agritourism operators for improving their efficiency.

Action

The University of Arkansas's Survey Research Center (SRC) was commissioned to survey owners and/or operators of agritourism businesses in Arkansas. The Arkansas Agritourism Initiative had compiled a list of 318 agritourism operations that served as the subjects for this study. From that list, SRC was able to obtain completed surveys from 102 agritourism operators.

Impact

This agritourism research utilized survey data analyzed at the regional level to obtain additional insights that may be left unnoticed if the analysis only considers data at the state level. The current analysis revealed that farm operators' and/or landowners' perceived future success in the agritourism industry in Arkansas entail different types of assistance depending on the regional location in the state. The types of assistance identified were support in training the farm operators; agritourism promotion and marketing; and awareness of the impact of laws and regulations on agritourism. State government's sponsored training in agritourism along with marketing and promotion are viewed as the most important factors in all studied regions that affect operators' decision to participate in the program. However, the following regional variations were manifest in the results. In the Ozark region providers were more receptive to face-to-face training interactions while the Delta providers appeared to prefer newsletters and news releases. Regarding laws and regulations, property and water rights are given more emphasis in the Ouachita region, but assistance with grant resources was an identified need in the Ozarks. Delta farmers were interested in receiving help with the identification of niche markets while Ouachita providers were concerned with promotion and marketing assistance. The information could be very beneficial to extension leaders and administrators at the Arkansas Department of Agriculture as they plan future agritourism programs in the state.

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Trade Adjustment Assistance Program

Issue

Agricultural enterprises face intense competition from growing imports of agricultural products. The Southern Risk Management Education Center (SRMEC) was awarded to the University of Arkansas in the winter of 2009. One of the programs managed by the Center is Trade Adjustment Assistance (TAA), a USDA technical assistance program. The program serves producers of agricultural commodities that have been severely adversely impacted by import competition.

Action

The SRMEC is responsible for the program throughout the southern region and built a network of at least one TAA state contact in each state in this region. These representatives help promote the program to commodity groups and producers as well as to identify educators—commodity team members—best suited to develop materials and deliver training sessions. The Center trained these representatives twice and maintained ongoing correspondence throughout the year. The SRMEC provided national leadership to the shrimp and catfish petitions. The Center coordinated the delivery of the TAA for Farmers training program and is working with Extension and Sea Grant experts from 12 states in the southern region to develop curriculum that will be delivered in traditional workshop formats as well as online.

Impact

The TAA program is currently working with a core team of 35 curriculum development and local educators scattered throughout the region. The SRMEC estimates approximately \$1.74 million in sub-contract awards (an estimated \$350/applicant) would be granted to Cooperative Extension Services and Sea Grant personnel in the southern region to deliver the program. The potential payout (direct financial payments to applicants) is estimated to exceed \$50 million to regions producers which is up to \$12,000 per applicant that successfully completes the program.

The National TAA program received over five thousand applicants from across the country, with 94% of all program applicants residing in the southern region. The SRMEC led activities that resulted in over four thousand approved applicants being trained.

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Funding

USDA National Institute of Food and Agriculture; University of Arkansas Division of Agriculture

Arkansas MarketMaker™

Issue

Local food marketing has continued to expand within the state as the number of farmers' markets and growers interested in marketing directly continue to expand. Farmers, retailers and institutions are attempting to participate in the local foods momentum at unprecedented levels. Retailers are scrambling to identify viable vendors to supply agricultural products and consumers are searching for enhanced experiences beyond the consumption of food. As a result, the demand for understanding and transparency of local food systems has grown because of the multitude of marketing strategies used and the myriad of product brands ranging from local, to organic, to natural.

Action

Arkansas MarketMaker™ was launched in March 2010 as an online marketing resource available to Arkansas' farmers, businesses, and consumers. It is an interactive web resource aimed at promoting the products and businesses of agricultural producers by connecting food producers, distributors, buyers, and sellers to their specific consumer markets. Using a web based search engine of databases in a GIS (global information system) environment, MarketMaker links food producers with economically viable markets, while aiding in food security and enhanced quality in food supply chains.

Arkansas joined an emerging national network that now features 18 states and a collaboration that features one of the most extensive collections of searchable food industry related data in the country. Farmers, retailers, restaurant owners/chefs, and farmers' market managers all benefit from being connected. Successful activities include developing MarketMaker promotional material and updating online educational and marketing resources, including updating the Extension Website promoting MarketMaker, a series of presentations to stakeholders and clientele promoting its capabilities, and some promotional newsletter and newspaper articles.

Impact

According to website analytics, the site averages almost 1,400 users and 17,000 website hits per month since its release in March 2010. The interactive database features 70 unique farm business profiles, 45 different farmer's markets and over 10,000 non-farm businesses. The Arkansas project is part of the national MarketMaker network which was recognized by National Institute of Food and Agriculture with a 2010 Partnership Award.

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Funding

USDA CSREES; Arkansas Farm Bureau; Arkansas Agriculture Department; the Wal-Mart Foundation; University of Arkansas Division of Agriculture

Expansion of the specialty cut flower industry in Arkansas

Issue

Interest in buying locally grown agricultural products is reflected in the increasing number of farmers' markets. Consumers are more concerned with the quality of the produce and environmental impact of shipping goods from producers thousands of miles away. When cut flowers are shipped a long distance before reaching consumers, freshness and quality are often sacrificed. Buying produce directly from local farmers and growers reduces the distance that produce travels and its carbon footprint, which in turn decreases global environmental pollution.

Action

A group of University of Arkansas collaborators and a group from industry joined forces and targeted potential and existing specialty cut flower growers in the Mid-South. The project impacted grower knowledge through a regional two-day grower workshop, an indexed resource manual, an extension fact sheet, and electronic resources in specialty cut flower production and marketing.

Impact

The workshop was attended by 95 people from 23 states. The project increased knowledge and skills of current/potential specialty cut flower growers, university faculty, and other agricultural professionals and industry influencers in the topic of specialty cut flower production and marketing. As a result of participating in this project, growers are in a better position to manage overall production and price risks. Feedback from a post-workshop survey indicated that: 32% of participants changed or used a new marketing strategy; 24% joined a professional or trade organization; 92% networked with other growers; 44% consulted with outside experts (e.g., lawyer, accountant, grower consultant); 52% changed their crop schedule or operation practices; 16% started a cut flower business; 56% diversified their products or services; 48% enhanced their business pricing and/or record keeping processes; and 36% adopted a new production technique; 52% adopted new cut flower crops.

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Funding

Southern Region Risk Management Education Center; University of Arkansas Division of Agriculture

Networking strategies to promote and improve the farmers' market experience in Arkansas

Issue

Interest in local foods is growing among consumers and producers. As a result, there has been a significant growth in

small scale farming and farmers' markets in Arkansas. The new and established farmers' markets are facing challenges. 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 have education and training needs in order to better serve the markets and customers. This project addressed the growth in markets with the following objectives: to conduct a statewide conference in order to provide useful information directly to market managers and vendors at Arkansas farmers' markets; to enable Arkansas farmers' markets to adopt new market management practices or procedures; and to form an alliance among community farmers' markets in northwest Arkansas that will allow future collaborative efforts.

Action

Actions of this project were to conduct a statewide Farmers' Market Conference, conduct Mystery Shopper and Customer Surveys, and develop a regional farmers' market alliance.

An annual statewide Arkansas Farmers' Market Association (AFMA) meeting has been started and was recently hosted by our project group. Conference planning and coordination were by a committee comprised of numerous farmers' markets, the AFMA board, the University of Arkansas, the National Center for Appropriate Technology, Southern Sustainable Agriculture Working Group, and the Fayetteville Visitors and Conference Bureau.

The project staff worked with nine farmers' markets in northwest Arkansas and three in central Arkansas to conduct Mystery Shopper evaluations and Customer Dot surveys. These tools are two techniques in the Rapid Market Assessment toolbox (extension.oregonstate.edu/catalog/pdf/sr/sr1088-e.pdf). Market managers and board members from survey participant markets were invited to a workshop to learn how to use these techniques for their market. From this project, the Northwest Arkansas Farmers' Market Alliance (NWAFFMA) was developed.

Impact

The results of this project benefited market managers and producers directly, and thereby will benefit consumers of local foods. The largest participation in an AFMA conference to date occurred. Twelve markets were evaluated by the Mystery Shopper exercise and 644 customer surveys were collected across these markets. The survey was used as both a model and demonstration of how surveys can be conducted by markets, and how survey results may be used to benefit the market. This topic was well received and resulted in several markets conducting their own assessments.

Customer survey results verified that for 75% of customers the most important reason for shopping at the farmers market was the availability and access to local produce. Additionally, 77% of survey consumers said they would visit nearby businesses not associated with the market but in proximity to the market. It was learned that the markets needed improved directional signs for access and parking, and additional seating was needed for market customers. Markets ranked high on reasonable parking access, vendor friendliness and, logical traffic/pedestrian flow through the market.

The newly created Northwest Arkansas Farmers Market Alliance was formalized by creating an organizational structure, electing board members, and developing a charter and by-laws. The NWAFFMA developed the following mission statement: "to support and promote the success, development, and benefits of local FMs as a viable resource for communities." The group has worked to secure additional funding to foster and encourage the growth of Northwest Arkansas markets and producers.

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Cooperators

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Funding

USDA – Farmers Market Promotion Program; University of Arkansas Division of Agriculture

Economic feasibility of on-farm storage

Issue

The interest in grain storage in Arkansas and other states has escalated in recent years. While Arkansas has historically relied heavily on off-farm (commercial) storage, a number of factors have led to increases in the amount of on-farm storage. In addition to the increasing demand for U.S. corn and soybeans, some additional reasons for the interest in on-farm storage are (1) increasing acreage of specialty crops and the need to preserve the identity of crops; (2) farmers changing their crop mixes due to production flexibility; (3) producers using larger trucks, making it easier for them to haul grain directly to its final destination, thereby bypassing local grain elevators; (4) harvest time bottleneck concerns; (5) commercial grain drying costs; and (6) basis and futures price volatility.

Action

The Department of Agricultural Economics and Agribusiness (AEAB) in cooperation with Biological and Agricultural Engineering (BAEG) plays a vital role in helping producers assess the cost of on-farm storage. Grain storage costs have both fixed and variable components. To assist producers in making on-farm storage investment decisions, team members from AEAB and BAEG designed a user-friendly spreadsheet model that provides estimates as to what grain storage facility costs might be based on a number of design variables. This decision aid is now available on the University of Arkansas Cooperative Extension Service Website.

Impact

On-farm storage capacities around the state range from approximately 9,000 to 200,000 bushels with total investments ranging from \$30,000 to in excess of \$600,000. The choice of storage options depends on the relative cost of each one and how it fits into the producer's overall harvesting, handling and marketing system. First, bin costs vary widely, depending on options and types of equipment. Construction site preparation

can also affect total investment. Therefore an individualized and unique analysis must be prepared for each storage facility. Given the average size investment of these facilities, it is crucial for the investor to obtain a preliminary assessment of the feasibility of on-farm storage.

Storing grain beyond harvest greatly increases the producer's marketing opportunities, flexibility, and possibly net selling price. From a producer's perspective, commercial storage costs are characterized as being variable cost only. Statewide commercial grain storage costs range from 5¢ to 10¢ per bushel per month. In addition, commercial grain drying costs for Arkansas producers can be \$30 to \$70 per acre depending upon crop, yield, and grain moisture content. Given the significance of commercial grain storage and drying costs, Arkansas' producers certainly have a financial incentive to assess the costs and benefits to their operation that may be accrued from on-farm storage facilities.

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Funding

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

Commodity marketing education

Issue

Arkansas producers find themselves today in a turbulent marketing environment that includes both a worldwide perspective and greater speculation in agricultural commodities. Extreme commodity and input price volatility requires producers to have a better understanding of budgeting and commodity marketing for the purpose of managing price risk.

Action

Row crop and livestock producers throughout Arkansas can benefit from educational programs that address commodity marketing concerns. Short courses and seminars are available to agricultural producers, lenders, and other interested parties. The curriculum consists of: cash marketing, marketing plans, technical analysis, futures and options, market outlook, and other marketing related skills such as identifying production costs and determining break-even prices. The intent of these courses and seminars is to provide participants with both knowledge and skills to apply in a variety of farm business situations.

County extension offices and agricultural lenders are increasingly offering this type of educational programming in a traditional classroom setting or through small group meetings such as local marketing clubs to help increase grower knowledge of price risk management. In addition, assistance is also offered through individualized instruction. Instructors are frequently in contact with clientele to review and evaluate progress on course content.

Impact

For many, futures and options can be complicated and mastery of this subject matter can take years. Program participants in four (4) counties were introduced to and practiced using a variety of pricing tools to develop knowledge and confidence. Generally, each workshop was designed as a three-hour program, with an in-depth review of pricing tools, ranging from a basic forward contract to options strategies that establish minimum and maximum prices.

Following these courses and seminars, some participants extended their knowledge to other producers by providing leadership for marketing clubs. Local marketing clubs have created additional opportunities for extension staff to communicate marketing skills to a broader audience of producers. Clientele participants receive financial benefit from their education as well as other skills. Many producers report the adoption of a written marketing plan and greater confidence and willingness to use a variety of marketing tools.

County extension agents have received positive feedback through evaluations and are pleased with the participation in these workshops. Additional county offices will offer educational seminars and workshops in 2011 to help increase grower and agricultural lender knowledge of risk management using commodity futures, options, and other cash marketing instruments.

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Molecular diagnostics of bed bugs

Issue

Bed bugs, *Cimex lectularius*, are blood feeding insects of people and have regained attention in the United States due to their recent resurgence. Adult bed bugs can usually be identified from other insects that resemble them, such as bat bugs and poultry bugs. However, identification can be difficult when only degraded or partial samples are available. A molecular diagnostic method to confirm the presence of bed bugs is desirable given the high cost (thousands of dollars) for bed bug treatments in human structures.

Action

A molecular diagnostic technique applying multiplex polymerase chain reaction (PCR) was developed in order to distinguish bed bugs from other insects and ticks that frequently occur in human homes. The technique was successful in distinguishing bed bugs from these other arthropods, including bat bugs, fleas, cockroaches, and mosquitoes. The technique was also successful for bed bug eggs, leg fragments and degraded samples.

Impact

This multiplex PCR technique was sensitive enough to

differentiate bed bugs from the eastern bat bug, which can also occur in human structures in the United States. This new assay provides a convenient way to identify bed bug eggs and fragments of bed bug adults when samples are too degraded for traditional identification. This technique should be an important new tool to confirm bed bug infestations in human dwellings, when intact whole specimens are unavailable, or when species confirmation is needed. The utility of species identification from this simple method allows targeted control of bugs that are associated with dwellings, and may prevent costly treatment of homes for bed bug infestations when it is not warranted.

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Volatility skews and implied agricultural price distributions

Issue

Price volatility is a major problem facing U.S. agriculture. Higher levels of volatility are due in part to the proliferation of bio-based products, increased globalization, and structural changes that have upset long-term price relationships. Regardless of its source, volatility in commodity markets affects all actors in the food system. The long-term viability and sustainability of the U.S. food system depends on the ability of U.S. farmers and agribusinesses to understand, manage, and forecast marketplace volatility. Volatility, however, is not directly observable and is not constant over time. There is a need to better understand price volatility and ultimately use this understanding to provide better models and management tools to producers and other participants in the marketplace.

Action

University of Arkansas Division of Agriculture researchers are implementing an ambitious research program of analysis of volatility skews that can be recovered from agricultural options markets using innovative methods from financial economics. During the past year, these efforts have emphasized volatility skews implied by prices for commodity options on hogs and cattle. Both markets show a persistent leftward volatility skew but the skew is much more pronounced in live cattle. One important research question is whether the volatility skew contains information on the probability of a large price change. This question is being addressed by measuring volatility skews just before releases of USDA reports and determining whether they can be empirically linked to the direction of the large price changes that often result. Findings indicate that some responses in hog futures prices could be explained by characteristics of the pre-report volatility skew. However, there is little evidence linking the volatility skew to post-report responses in live cattle futures.

Impact

As a practical matter, findings from research conducted

to date indicate that the use of options to insure against large price declines is considerably more expensive than the use of options to insure against similarly large price increases. In other words, out-of-the-money put options are expensive in livestock markets and this is especially the case for out-of-the-money put options on cattle futures. Findings such as these contribute to a better understanding of the roles that commodity futures and options markets play in the price discovery process and are germane to the cost effectiveness of options hedging. This understanding is critical to decision makers in government, industry, and on the farm.

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University of Arkansas Division of Agriculture

Intergenerational family relationships: contributions and implications for quality of life among midlife and older adults

Issue

Increasing numbers of aging adults in Arkansas will lead to growing needs for frail elders in coming decades. Ninety-five percent of older adults in need of assistance rely on younger family members for support. Determining factors contributing to positive intergenerational relationships will facilitate stronger support networks as well identify those older adults most in need. The knowledge gained from these research efforts will lead to the development of interventions that can help strengthen family relationships to lessen the social and economic dependence of frail older adults on local and state services.

Action

Research investigating what helps and hinders regarding satisfaction with the Mother-in-law/Daughter-in-law relationship illuminates a critically important factor in strengthening intergenerational family relationships. Previous research has suggested that when the child available to provide care for an aging parent is a son, the responsibilities for that care fall primarily on the daughter-in-law. Therefore, acceptance and satisfaction with that relationship is important in achieving adequate care for older adults. For daughters-in-law, three-fourths of the difference between satisfied and unsatisfied was explained by the age of the daughter-in-law, length of marriage, and satisfaction with her husband as well as three of the styles for relating to their mother-in-law. For the mother-in-law, three fourths of the difference between satisfied and not satisfied was related solely to the mother-in-law's satisfaction with her relationship with her son. This finding is not evidenced in previous research. The significance of the finding of the role of the son/husband in determining satisfaction for both of these women, especially the mother-in-law, provides insight into a specific area for intervention that can clearly make a difference in the availability of support for frail parents.

Training sons/husbands in relationship and communication skills will strengthen the bond between their mothers and wives so that mutual support can be available for both across the adult life span of both women.

Impact

Resources available for governmental support systems to provide care for frail elders will be increasingly limited. Interventions that facilitate strengthening intergenerational family relationships will reduce the economic and social costs of caring for older adults. Providing training in relationship skills will facilitate the development of more family members willing and able to care for aging family members.

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University of Arkansas Division of Agriculture, AES research support

Travel and spending characteristics of the mature biker: an exploratory study

Issue

Despite the growing popularity of motorcycling, very little data exist identifying the interests of the mature rider. The current study investigates the mature riders' spending habits at motorcycle festivals (rallies), their leisure motivations regarding motorcycle riding and a demographic profile of the age 50 and older biker. The study contributes to a research area that is currently lacking, especially relative to the market growth realities described above.

Action

The researchers developed an attendee questionnaire which was administrated during the four day 2009 Bikes, Blues, and Bar-B-Que (BBB) event held in Fayetteville, Arkansas. The sample consisted of 750 attendees of the BBB festival resulting in the return of 721 useable surveys. Of the 721 useable surveys, 253 indicated the participant was 50 years of age or older. These 253 respondents became the focus of this paper. Descriptive statistics were used to determine the spending characteristics of the mature BBB tourists relative to hotels, restaurants, and shopping.

Impact

The findings provided an accurate demographic profile of the midlife and older BBB attendees and their spending patterns. It was determined that the average BBB attendee was a male, over 50 years of age. He rode his motorcycle (61%) up to 400 miles to attend the event. The average 50 and older boomer biker stayed in an area hotel and ate out in Fayetteville restaurants an average of six times during their time at the event, which was typically two days. In addition, midlife and older bikers planned to spend from \$51 to over \$200 on official BBB souvenirs while at the event.

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Bikes, Blues, and Bar-B-Que: Shopping and tourism patterns

Issue

Documentation and analysis of the demographic characteristics, shopping beliefs and spending habits of attendees of an annual fall event called "Bikes, Blues and Bar-B-Que" in Fayetteville would provide data that may be useful to organizers of such events. Documenting the impact of spending behaviors on local hotels and restaurants would also be useful.

Action

A six-section 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 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 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.

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Object-based classification vs. pixel-based classification: comparative importance of multi-resolution imagery

Issue

Remotely sensed imagery, in the form of satellite and aerial photography, has become an indispensable tool in resource management and in numerous areas of scientific research. In the past, most Land Use/Land Cover (LULC) classifications

have been created using a pixel-based analysis of remotely sensed imagery. These pixel-based procedures analyze the spectral properties of every pixel within the area of interest, without taking into account the spatial or contextual information related to the pixel of interest. The first objective of this research was to determine if an object-based analysis of remotely sensed imagery would produce a LULC classification that is statistically more accurate than a pixel-based analysis when applied to the same imagery. The second objective was to determine the relative importance of multi-resolution image datasets to classification accuracy for the above methods.

Action

The research study area was located in and around the city of Hot Springs, Garland County, Arkansas, and included Hot Springs National Park. Two SPOT-5 images were used to provide multi-temporal data (winter and spring), each with different foliage characteristics (leaf-off and leaf-on) for the study. A true color (RGB) digital aerial image at 1-foot resolution and a 1-meter color infrared (CIR) digital orthophoto quadrangle (DOQ) were captured using the Leica ADS40 camera system. The CIR image was acquired during leaf-off conditions. The CIR DOQ, SPOT-5 Leaf-on, and SPOT-5 Leaf-Off image datasets were merged into an 11-band image (CIROnOff, 1-meter). Likewise, the CIR DOQ and SPOT-5 Leaf-off images were merged into a 7-band image (CIROff, 1-meter) and the SPOT-5 Leaf-on and SPOT-5 Leaf-off images were merged into an 8-band image (OnOff, 10-meter). An object-based classification was produced from the SPOT-5 Leaf-on image (LeafOn, 10-meter). An object-based classification was produced from the three-subset PCA images: CIROnOff, CIROff, and OnOff, as well as the LeafOn image using Feature Analyst®. This software utilizes inductive learning algorithms to analyze the spatial context and spectral signatures of pixel clusters or neighborhoods. Pixel-based methodologies were performed using ERDAS Imagine® 9.3 and included both supervised and unsupervised classifications. In comparing the overall accuracies of the object-based classifications of the four image datasets (CIROnOff = 82.0%, CIROff = 78.2%, OnOff = 66.1%, and LeafOn = 58.9%), the multi-spatial/multitemporal image dataset (CIROnOff) produced the best

results. However, a comparison of the Z-scores and p-values for the object-based classifications indicates that there was no statistically significant difference between CIROnOff and the CIROff image datasets (Z-score = 1.426 and p-value = 0.0769). However, the CIROnOff and CIROff image datasets were both statistically different from the OnOff and LeafOn image datasets (all p-values < 0.0001). This emphasizes the importance of the 1-meter spatial resolution data when using the object-based method. A comparison of the supervised classification accuracies indicates that the CIROff image had the highest overall accuracy (71.8%). The overall accuracies of the unsupervised classifications show the CIROnOff image had the highest overall accuracy (66.9%).

Impact

Technological advances and the growing availability of high-spatial resolution imagery has focused attention on the limitations of traditional pixel-based classification methodologies and precipitated the need for more advanced methods. Object-based classification methodologies, that take advantage of both the spectral and contextual information in remotely sensed imagery, may hold the answer. This research has shown that when merging CIR high-spatial resolution aerial imagery with medium-spatial resolution satellite imagery, an object-based classification will outperform both supervised and unsupervised pixel-based methods.

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Funding

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Society-Ready Graduates

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 disasters 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. The earthquake in 2010 in Haiti has led to amputation of limbs for many thousands of people. 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 that can be manufactured locally in developing countries.

Action

Since 2006, University of Arkansas 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. Another team designed and implemented a testing machine capable of applying repetitive loading to prosthetic components to verify fatigue strength. Four successive teams have worked on simple designs for a low-cost prosthetic foot. The latest version uses spring steel. 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. Students held a Limb Drive in 2010 to collect used prosthetic devices for donation to amputees in Haiti. They collected over 16 prostheses, 21 sets of crutches, 11 walkers and 3 wheel chairs.

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 that will help them to develop into important players

in the worldwide 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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Impact of user centered design and usability testing on development of computer-based teaching modules

Issue

The rapid development of computers and software has led to a rapid expansion of e-learning technologies in many fields, but especially in education. However to design effective e-learning modules, the novice e-learning designer must understand the proposed learners and how these learners will be expected to use these tools.

Action

Training modules were developed on applying Hazard Analysis and Critical Control Point (HACCP) principles, quality aspects, and production information to individual poultry unit operations. Learning objectives were evaluated using discount usability testing techniques to optimize the delivery system and to ensure a satisfactory e-learning experience. Discount usability testing of this virtual orientation was successful in obtaining vast amounts of feedback. Usability issues with the training materials were identified. Expected completion times were not met by most of the beta test participants, indicating that a change in the format of the course might be necessary, perhaps segmenting the modules into smaller sections to be reviewed independently of one another. Another suggestion by the evaluators was to include narration for the sections, which might in turn speed up the completion times. A navigation error was discovered by these users, as well as other critical errors in design. Other errors, such as font inconsistencies and page design problems, were also discovered by the participants.

Impact

Training modules can be developed by a well-informed novice design team. User centered design coupled with usability testing provides for more successful e-learning products and improved user satisfaction. Usability testing expenses can be vastly reduced by focusing on reduced numbers of testing participants, avoidance of elaborate testing facilities, and establishing clear objectives with a concise testing outline.

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Reflective practitioners leading to excellent professionals**Issue**

Today's students are accustomed to processing information with the aid of electronic devices that allow instant feedback and multi-tasking. These processes do not encourage reflective thinking. In order to educate today's technological advanced students to think reflectively about their educational processes and integrate newly constructed knowledge, reflective exercises are incorporated as teaching strategies in agriculture. Students must evaluate their teaching strengths and weaknesses in order to improve their practice before field experiences are initiated.

Action

Through the use of faculty start-up funds, a digital video recorder and DVD burner were purchased to record and make usable copies for enrolled student reflective practices. During the fall semester in AGED 3133 Methods of Agricultural Education, students engage in individual practice teaching sessions (micro teaches). Throughout the semester, students demonstrate skills to a group of students through a variety of teaching practices identified as engagement practices. There are three of these "micro teaches" that each student must accomplish. Each of these "micro teaches" are recorded and burned to a DVD to facilitate each students' viewing and writing reflective summaries consisting of best practices and items needing improvement.

Impact

This educational reflective practice invites students to view their abilities and styles while leading a group of students. By making the student reflect on their actions through a "micro teach," students identify strengths and weaknesses and incorporate those experiences into perceptions of efficacy of teaching. This process leads to identification of areas to work further towards and areas of proficiency. Initial results from the previous year's participants indicated improved knowledge towards strengths and weaknesses. Further studies will be undertaken of these initial findings. Reflection has been deemed by numerous scholarly research studies as an effective teaching tool when incorporated in the learning process of post-secondary students.

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Biodiesel education through a mobile demonstration unit in secondary schools**Issue**

There is a need to identify and develop instructional systems that meet 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. There is much uninformed knowledge held by the general public concerning biodiesel, 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® 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 the performance aspects of these two fuel sources and generate personal perceptions as a result of this educational venue.

Impact

This project provides firsthand knowledge related to biodiesel production, use, and performance. Demonstrations at secondary locations have impacted more than 15 schools with over 500 participants. Analysis of data gathered through this project has given rise to significant results leading to higher knowledge acquisition and perceptions of biofuels.

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Arkansas Soybean Promotion Board; U.S. Department of Energy; FutureFuel Chemical Co.; University of Arkansas Division of Agriculture, Arkansas Agricultural Experiment Station

Learning agricultural communications industry practices through hands-on coursework**Issue**

Students graduating with college degrees are required to have diverse skill sets. Additionally, the field of agricultural

communications continues to expand, broaden and diversify requiring graduates to possess an array of competencies to meet industry demands. When preparing students for industry positions, it is often a balancing act to teach them the knowledge necessary to be successful while providing them opportunities for real-life, practical experience. Agricultural communications students must have the ability to plan, develop and administer effective communication campaigns while working one-on-one with a client. This opportunity allows students to work directly with a professional to apply competencies and skill sets learned in previous courses to create an effective integrated marketing communications modeled campaign. An integrated marketing communications campaign focuses on the need to create a holistic marketing, advertising and public relations plan to rollout a new product or service.

Action

Practical experience working in teams directly with a business client to develop a holistic communications campaign guided the AGED 4343 (Communication Campaigns in Agriculture) course offered in Fall 2010 through the Dale Bumpers College of Agricultural, Food and Life Sciences at the University of Arkansas. The course was designed to provide students with knowledge, competencies and skill sets to develop an understanding of the principles, practices and applications of social marketing, integrated marketing communications, branding, advertising and public relations as they pertain to developing communication campaign strategies for the agricultural industry. Students developed, using a team approach, a communication campaign for an agricultural company and/or entity focused on a specific product or service. Graduate students served as project directors for an undergraduate campaign team and acted as the mouthpiece for the agency. Each team worked with a different client.

During the semester, students put into practice what was learned in classes as they developed their client-centered campaign, which was produced as a formal plans book, professionally formatted and laid out. It included a situation analysis; research report; three-tiered budget; goals, objectives, strategies and tactics report; campaign timeline and implementation plan; media plan; evaluation/feedback plan; and at least eight communication pieces that consisted of letterhead and business card, print news release, print advertisement, brochure, website and at least three additional communication pieces that met the goal(s) of campaign). At the beginning of the semester, each student agency pitched their campaign plan to their client. At the end of the semester, each student agency completed a formal 25-minute presentation to their client using a timed-PowerPoint to present the key campaign elements.

Impact

Students are more engaged in learning, discussion and contributing when they are working one-on-one with a client. This course allowed students to work as a team to develop client-driven campaigns that were utilized in three organizations. Participation in practical application of in-class lessons provided students with real-life work skills that positively impacted their level of learning. Graduate students and under-

graduates were able to work together to create all the necessary components in a campaign. This course is offered as a senior-level capstone course in agricultural communications and has gained popularity in other majors.

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Agricultural communications and apparel studies students learn industry competencies in graphic design while sharing expertise in their respective fields – a model for faculty when building educational alliances

Issue

With reduced budgets impacting universities, faculty search for creative, low-cost ways to educate students in the diverse skill sets needed in industry. It is critical for faculty to create new alliances in order to expand the number of students enrolled in each course. Additionally, graphic design is an area of expertise needed by both agricultural communications and apparel studies students. Therefore, faculty from these respective fields collaborated to design a course that would meet the needs of students training in these dynamic fields. Faculty met to make decisions regarding the critical skills needed by students, priorities were ranked, and a course was designed around needed competencies.

When preparing students for industry positions, it is often a balancing act to teach them the knowledge necessary to be successful while providing them opportunities for real-life, practical experience. This course was designed to allow apparel studies and agricultural communications students to develop the necessary skills and competencies to be successful in graphic design while providing them with a theoretical base in layout and design. Students gained competencies in Photoshop, Illustrator, and InDesign (Adobe Creative Suite).

Action

Practical experience in graphic design with a theoretical understanding in layout and design guided AGED 4243 (Graphic Design in AFLS). A course was offered in Spring 2010 through the Dale Bumpers College of Agricultural, Food and Life Sciences. For this course, students met twice weekly in a lecture/lab setting to learn competencies and practice skills. Students completed daily assignments that highlighted skills acquired in software and layout and design, but assignments were open enough for students to be creative in their respective fields of study. Students also learned skills from the other discipline area. For example, agricultural communications students learned to create clothing options in Illustrator while apparel studies students learned how to complete a magazine layout. Additionally in the course, students learned how to contact printers and create budgets.

During the semester, students put into practice what was learned in class as they manipulated photographs, created raster and vector graphics, developed clothing designs, created a brand and a logo for personal use and for a company of their choice, and completed an 8-page magazine layout. Students used works created throughout the course to complete their magazine layout. In general, apparel studies students created a fashion magazine and agricultural communications students created a livestock sale catalog or an agricultural publication.

Impact

Students are more engaged in learning, discussion and contributing when they have the opportunity for hands-on learning and the opportunity to use their creativity. Instructors can provide meaningful opportunities for students in multiple disciplines when they work one-on-one with faculty to develop courses that meet industry needs. In this course, students' blogged about designs and the opportunities and challenges of graphic design allowing others in and out of their discipline area to learn from their struggles and triumphs. Participation in practical application of in-class lessons provided students with real-life work skills that positively impacted their level of learning. This course is offered as a junior/senior level course in agricultural communications and apparel studies and is gaining popularity in other majors.

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The educational effectiveness of utilizing Second Life (SL) in teaching graduate-level agricultural crisis communications – phase II

Issue

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 engage in problem-solving and decision-making simulations in the context of real agriculture and natural resource crises.

Action

Phase II of this funded three-year research project is underway. The following research projects are components of year two research (June 2010 – May 2011).

Project Title: Understanding Industry Needs for Crisis Communication Training across Agriculture – Delphi study

- Population: Agricultural communicators in the United States
- Instrument – Online survey
- Data collection underway and includes professionals identifying crisis communication training competencies and needs for new professionals.

Project Title: Understanding Second Life: Student Resident Perspectives

- Population: Students actively involved in Second Life
- Instrument: Focus group protocol
- Data collection took place in fall 2010. The goal of this study is to gain a better understanding of student use of Second Life. Findings will be used to guide development of lessons to be delivered via Second Life.

Project Title: Evaluating Second Life Island Usability

- Population: Undergraduate and graduate students in Colleges of Agriculture
- Instrument: Self-guided prototype testing and usability testing instruments
- Data collection will take place in late Fall 2010 and early Spring 2011. This study involves the use of Centra, an online conferencing system, to allow exact “clicks” and “use” of the environment to be observed and ensure usability.

Project Title: Evaluation of Crisis Communications Simulations in Second Life

- Population: Students enrolled in Texas Tech University ACOM 5304
- Instrument: Online survey (modification of previous instruments), implementation logs, and chat room discussion texts
- Data collection will take place at the beginning and end of Fall 2010 semester at the time that the course under investigation is delivered via Second Life. The goal is to document student reaction to the use of Second Life and measure learning.

Current Progress: The Second Life island (AgriCulture) has been built and includes both urban and rural industry. During the Fall 2010 semester students experienced a crisis simulation involving a hurricane patterned after Hurricane Katrina. Students participated in reflection journals during the experience; analyses of the students' journals are underway.

Impact

Outcomes of this study are meeting the needs of student learning and competencies in crisis communications by providing real-life, virtual educational opportunities. Students in agricultural communications are able to participate in a crisis simulation to gain practical application of knowledge and competencies taught in the classroom. Students complete pre-, during and post-crisis communication plans, participate in gathering information, collaborate with industry professionals and peers, and conduct press conferences after the crisis to inform the public of the actions taken to minimize and reduce the risk and fall-out of the crisis. Students worked in communication teams to plan, strategize and carry out their communication plans. The development of this crisis simulation and

model has enhanced the breadth and quality of instruction available to students at all levels.

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University of Arkansas Division of Agriculture

Visual communications on the road in Arkansas: providing agricultural communications curriculum to secondary agricultural science teachers

Issue

Based on preliminary research, Arkansas' agricultural science teachers lack knowledge and competencies in agricultural communications. Data further demonstrated that teachers perceived technology abilities by their students as intermediate to proficient; while teachers believed their abilities were intermediate but not proficient. This finding suggests that students and teachers may not be meeting medium proficiency standards for the use of digital technology in communication (US DOE, 1996). Because many digital natives (youth growing up in the digital era) are interested in technology, and high schools in Arkansas teach minimal content in agricultural communications, a need to develop curriculum and activities in visual communications existed.

Action

Through this project, an asynchronous, agricultural communications curriculum was created specifically in writing, photography and videography (visual communications and technology), and careers in agricultural communications. Specifically the curriculum focused on: (1) Writing: effective writing, grammar and punctuation, writing for an audience, writing in agriculture, identifying a good agricultural story, interviewing, and storyboarding; (2) Photography: selecting a camera, proper camera use, photo composition, and shooting livestock, row crops, and machinery in motion; (3) Videography: selecting a camera, proper camera use, videoing techniques, managing raw video, editing, digital titles, adding music, and publishing in public domain (specifically *You Tube*); and (4) Careers in Agricultural Communications: career opportunities in Arkansas, the United States, and internationally, utilization of agricultural communications skills in specific segments of agriculture, and information about agricultural practices and production.

The project is currently in Phase I, pilot testing with four high schools in Arkansas. Once the curriculum was devel-

oped, project faculty met with teachers from four participating programs to provide curriculum training and to schedule the mobile classroom visit. High school students participated in a full-day, experiential learning activity, using the mobile classroom. Students applied knowledge learned via curriculum units to create a three to five minute promotional video about agriculture.

Impact

Secondary agriscience programs are able to integrate agricultural communications curriculum into their courses while still meeting the current frameworks guiding their programs. A pre-test and post-test for each content area and a cumulative delayed post-test were administered to measure knowledge growth of the students. In Phase I of the project, participating secondary agriscience teachers provided curriculum feedback; thus, aiding in curriculum revisions. The curriculum is available to all Arkansas agriscience programs. Phase II will launch in January of 2011 and the visual communications and mobile classroom experience will be delivered to 12 to 15 additional high schools in Arkansas. Continual program evaluation will occur throughout the project.

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USDA-NIFA; University of Arkansas Division of Agriculture

Web-based videos developed as plant biology teaching tools

Issue

The ways that young people learn and communicate are changing rapidly. Students spend much more time using computers and electronic media than they ever have before. It is difficult to get students excited about studies in the plant sciences, and so new teaching techniques must be developed that incorporate interactive video and internet tools.

Action

We guided a small group of high school students enrolled in TV production courses to write, produce, and perform in a series of short educational videos to appeal to students from grades K-8. The work was initiated to provide a fun starting-off point for teachers who want to present basic principles of plant biology. The videos have been posted on a website, which also contains links to many other educational activities and websites. "Plant Clippings" is a website centered on a collection of 10 short videos, each highlighting different principles of plant biology. The episodes involve two fictional detectives solving plant-based crimes for the Photosynthetic Organ-

ism Detective Service, or PODS. The videos were developed in collaboration with Peggy James at Fayetteville (Arkansas) High School. Each video contains questions for the students to discuss.

Impact

In addition to developing a new website (<http://plant-clippings.uark.edu>), we established a Youtube channel and a Facebook account. We also printed 1500 DVDs containing the video episodes, and these will be distributed for free nationally and locally at teacher conferences and workshops.

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Funding

American Society of Plant Biologists Education Foundation;
University of Arkansas Division of Agriculture

Understanding linkages among technology, economics and societal values

Issue

Solving complex problems in the face of increasingly rapid change requires that those of differing expertise, experiences and perspectives have the ability to effectively communicate. This will necessitate the emergence of enlightened leaders whose skills include (1) a basic understanding of the linkages among technology, economics and societal values; (2) an ability to communicate effectively and knowledgeably about how change is being driven by these linkages and (3) a fundamental awareness of the indicators of the emerging chaos and the associated challenges facing humankind.

Action

Leaders of all types need to be enlightened as to how and why macro-level change occurs if the future is to be a time of sustainable prosperity and well-being. With this need in mind, three important aspects for understanding the nature of change have been developed: (a) a conceptual model; (b) a historical perspective; and (c) a statistical overview. These three aspects have been incorporated into seminars, workshops and speeches before a wide range of local, state, national and international audiences. Furthermore, the material has been developed into a 3-hour special topics graduate/undergraduate course intended for all disciplines.

Impact

The payoff is that leaders at all levels become more informed about the nature of change and better equipped to promote sustainable prosperity and well being. The target audiences are those public- and private-sector leaders at all levels with an interest in sustainability initiatives, communication among clientele groups, and personal awareness about

important trends that will greatly impact humankind in the foreseeable future.

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Native American students recruited for ecological projects

Issue

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, and 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 to develop and implement research projects.

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National Science Foundation; University of Arkansas
Division of Agriculture

The agricultural publications capstone course and the *AR Culture* magazine

Issue

As communicating with the public about issues related to agriculture, food, and the environment becomes more important, so does academia's ability to provide society-ready graduates who possess excellent communication skills. For decades, in colleges of agriculture across the United States, building students' communications skills has been a priority. Degree programs in agricultural communications exist in dozens of colleges across the country, most with the goal of providing the agriculture industry with graduates who are skilled in communications and also have a strong knowledge and passion for issues and topics related to agriculture, food and the environ-

ment. Preparing students with practical communications skills and giving them real-world experience to take into the work force are necessities.

Action

Two faculty in the University of Arkansas Bumpers College of Agricultural, Food, and Life Sciences created a capstone course called Agricultural Publications. This team-taught course was a culminating educational experience that allowed agricultural communications students to apply the skills they have learned throughout their academic careers. Students functioned as a publication production team to create a professional 52-page magazine (called *AR Culture*), which is currently being used by the Bumpers College for recruiting, development and public relations. Students conceptualized the magazine, assigned beats, wrote stories and captions, took photographs, edited copy, designed layouts, sold and designed sponsorships, and managed the pre-press production process. These skills, all learned in various courses throughout the students' undergraduate careers, were put to use for the first time in a realistic, practical, collaborative project.

Impact

The results of this effort are evident in the quality of the publication. The design and writing are outstanding and will be entered in several publication competitions in 2011. More importantly, the eleven students in the capstone course reported in a qualitative evaluation that the practical experiences gained through the course had already helped them land jobs and internships and that the magazine is a prominent piece in their employment application portfolios. They also reported a higher level of confidence in their readiness to communicate about agricultural issues in their future roles as agricultural communicators. In addition, the magazine became self-sufficient in its first year, with sponsorship sales completely covering the production and printing costs. A second edition of the magazine is planned for Spring 2012.

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Dale Bumpers College of Agricultural, Food, and Life Sciences/
Jack Justus Outstanding Teaching Award; University of
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Maximizing hospitality learning outcomes: an integrated experiential in-class approach

Issue

When evaluating recent research in hospitality education, findings indicate that there is a growing diversity of the hospitality student body, which is driven by cultural differences (home country differences, ethnic differences, age differences, etc.) and has implications for effective teaching methods and differences in preferred learning methods. Studies have

indicated differences in preferred learning styles for students of these differing age groups and backgrounds. To address these issues, faculty and administrators need to devise innovative ways of balancing learning diversity needs and efficiency needs.

Action

A study was conducted to assess the value of using an experiential in-class method to combine hospitality-specific content with more general learning outcomes demanded of successful graduates. While a number of experiential in-class methods are currently used by faculty in hospitality (e.g., case study, critical incidents, action research, and small group problem-solving), this study explored the effectiveness and efficiency in student learning by integrating content that is hospitality-specific but with an experiential approach emphasizing team processes and decision-making.

Impact

The value of this study is in exploring the ability to maximize classroom experiences for student learning of managerial skills and technical hospitality skills simultaneously. While this study provides some preliminary tests for an indication of effectiveness and efficiency using this experiential, in-class approach, additional value of this study lies in the sharing of innovative teaching methods across the hospitality education community.

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EU-US double degree program in rural development and agricultural economics

Issue

Study of the economics of agricultural and food production, marketing, consumption, policies and rural development policies is needed in a rapidly globalizing environment. A comparison of the economics and policy approaches in the United States and European Union provides a framework to learn about differences and similarities between these two major regions. Challenges for producers in these post-industrial regions include environmental constraints, bioenergy production, climate change, evolving consumer requirements, more intense involvement of the distribution and processing sectors, and significant changes in market structure and power. Competitiveness of agricultural and rural areas no longer solely depends on production efficiency but also on ability of regions to incorporate new requirements in production, processing, distribution and sales. This shift now requires highly-skilled specialists with excellent knowledge of trade, development and agricultural economic theory and practice, international policies, and models for rural development.

Action

A consortium of universities, led by the University of Arkansas and Ghent University (Belgium), was organized in 2008. This initiative has developed into an internationally recognized double master's degree program in rural development and agricultural economics.

Project activities have included: 1) finalizing a memorandum of understanding among consortia universities; 2) developing curriculum; 3) developing an organizational framework for student and faculty mobility and exchange; 4) implementation of transfer credit arrangements and a quality control and evaluation system; 5) developing a language and cultural exchange program; 6) recruiting and selecting students; and 6) providing faculty with mobility and advising opportunities.

Impact

The double degree master's program trains specialists with comparative knowledge on EU, U.S., and international agricultural economic and rural development theory, practice and policies. The double degree program offers educational innovation by using newly developed teaching methods based on participatory and action research approaches during case study and internship work, information technologies for international group work, and international study by students and faculty, thus providing exposure to a wide variety of faculty and practices.

At the end of the second year of the project, the first seven students have completed or are near to completing the program and their research theses on various topics. An additional eleven students are in the second year of the program. Six faculty have traveled, presented their research, and are developing collaborative research projects.

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Funding

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Insect Festival of Arkansas**Issue**

The public is very interested in insects, mites, ticks, scorpions, spiders, and other arthropods. In 2010, the University of Arkansas Department of Entomology sponsored the 12th Insect Festival of Arkansas.

Action

The Insect Festival of Arkansas brought together most of the entomologists in Arkansas. The day-long event contained numerous displays of live insects and other arthropods, means to control them, Museum specimens and a variety of crafts and activities for children. Altogether, 120 volunteers helped with the Festival in 2010. The 2010 Festival included a new educational event, "Insect Theater," in which actors dressed in insect costumes, accompanied by live music and lyrics, presented skits about metamorphosis, predation and food webs, to teach about insects and their roles in the world.

Impact

Approximately 4,000 children, teachers, parents, and others attended the 2010 Festival, including schools from throughout northern and central Arkansas, and even from western Oklahoma. The Festival allows teachers to integrate insects into their classroom curricula, and provides a unique educational opportunity for home-schooled children to visit the world of insects. Over the 17-year history of the Insect Festival of Arkansas, we have reached about 36,000 children in the state.

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Funding

University of Arkansas Division of Agriculture

2010 Publications of the Arkansas Agricultural Experiment Station

- [*DISCOVERY: The Student Journal of Dale Bumpers College of Agricultural, Food and Life Sciences, Vol. 11*](#)
- [*Economic Contribution of the Agricultural Sector to the Arkansas Economy in 2008*](#)
- [*Arkansas Wheat Cultivar Performance Tests 2009-2010*](#)
- [*Arkansas Corn and Grain Sorghum Performance Tests 2010*](#)
- [*Arkansas Soybean Performance Tests 2010*](#)
- [*Arkansas Cotton Variety Test 2010*](#)
- [*Animal Science Department Report 2010*](#)
- [*Wayne E. Sabbe Arkansas Soil Fertility Studies 2010*](#)
- [*B.R. Wells Rice Research Studies 2009*](#)
- [*Summaries of Arkansas Cotton Research 2009*](#)

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Conversions for commonly used units

$$1 \text{ ft} = 0.30 \text{ meters} = 30 \text{ cm}$$

$$1 \text{ inch} = 2.54 \text{ cm} = 25.4 \text{ mm}$$

$$1 \text{ ounce} = 28.3 \text{ g}$$

$$1 \text{ lb.} = 0.454 \text{ kg} = 454 \text{ g}$$

$$1 \text{ PSI} = 6.9 \text{ kPa}$$

$$1 \text{ ppm} = 1 \text{ mg} / \text{kg}$$

$$1 \text{ gallon} / \text{acre} = 9.35 \text{ L} / \text{ha}$$

$$1 \text{ lb} / 1000 \text{ ft}^2 = 4.9 \text{ g} / \text{m}^2$$

$$1 \text{ lb} / 1000 \text{ ft}^2 = 48.8 \text{ kg} / \text{ha}$$

$$1 \text{ lb} / 1000 \text{ ft}^2 = 43.56 \text{ lb.} / \text{acre}$$

$$1 \text{ lb} / \text{acre} = 1.12 \text{ kg} / \text{ha}$$

$$1 \text{ bushel} / 1000 \text{ ft}^2 = 3.8 \text{ m}^3 / \text{ha}$$

$$^{\circ}\text{F} = (9/5 * ^{\circ}\text{C}) + 32$$

$$^{\circ}\text{C} = 5/9 * (^{\circ}\text{F} - 32)$$

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