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Faculty Impact Statements 2008

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Faculty Impact Statements 2008

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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 2008 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 College and Experiment Station Web sites at:

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

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

Issue

Increased selection for body weight, breast meat yield, and FCR in broilers has lead to a number of metabolic disorders including the development of pale, soft, exudative-like (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 can vary dramatically in broiler flocks, it is estimated that PSE-like meat could cost a single processing plant 4.4 million dollars per year in lost product. This large economic impact has caused PSE-like meat to become an important issue in commercial broiler selection programs.

Action

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. Muscle color as measured through the use of a colorimeter is relatively inexpensive and can produce real-time data in the processing plant. L-value has been shown to be highly correlated both phenotypically and genotypically with muscle color. The high genetic correlations suggest that these two traits may be under similar genetic control. In addition, moderate genotypic and phenotypic correlations have been reported between L-value and drip loss.

The heritability of L-value in broilers has been estimated to be as high as 0.55. This high heritability suggests that direct selection for this trait could have the potential for rapid modification of muscle color in broilers. This, combined with the association of L-value with both muscle pH and drip loss, suggests that selection for increased L-value could lead to the development of broilers with an increased incidence of PSE-like meat. Thus, divergent selection for PSE-like meat in broilers was accomplished through selection for 24-h L-value in broilers from the HOG-1 RBC population grown to 42 days of age. Selection was based on sire-family means for 24-h L-value in breast meat resulting in the development of two lines selected for either increased 24-h L-value or decreased 24-h 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 multifactoral. One, 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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Funding

Division of Agriculture, University of Arkansas System

Genomic SNP 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 one hundred million dollars per year in the United States. In 2002, it was estimated that 8% of the 361 million broiler deaths each year can be attributed to ascites. Direct economic costs include losses due to on-farm mortality, mortality during transportation to the processing plant, and condemnations at the processing plant. In fact, 0.05% of all processing plant condemnations are attributed to ascites. 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 that, 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 or 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 upon in primary poultry-breeding programs and incidence of ascites.

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Funding
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Impact of diet and feeding program on growth and yield of commercial pheasants

Issue

Because of the increasing acceptance and demand for pheasant products in the national and international markets there has been a substantial shift from processing hunt birds to that of weight-selected high-yielding birds. Such selection has resulted in a shift from processing at a mature age of 20 weeks to a more juvenile age of 15 weeks. Since birds are being processed at younger ages they are less aggressive and perhaps more malleable to higher density rearing without concomitant increases in carcass damage.

Action

A study was conducted to titrate the rearing density of weight selected commercial pheasants. For this study, commercial pheasants were raised at densities of 2.0 sq ft per bird (standard industry density), 1.8, 1.6, 1.4, 1.2 and 1.0 sq ft per bird. In comparison, the commercial broiler chicken of today is reared at densities below 0.8 sq ft per bird. The impact of crowding was monitored by analyzing the growth and feed conversion of the commercial pheasant from hatch to 15 weeks of age. At the end of the 15-week period, the pheasants were processed to determine the impact of density environment on traits of economic importance such as breast and leg yield.

Impact

This study will result in changes in fundamental methods of rearing pheasants. Currently commercial pheasants are reared at 2.0 sq ft per bird. If it is shown that rearing at higher densities does not have a negative impact on feed conversion, growth and yield, then the pheasant industry has the opportunity increase the number of birds currently produced per house. This will instantly allow for more efficient utilization of available facilities and utilities. Thus, as the processed pheasant market expands, the need for additional housing will be reduced. In addition to the $250,000. per house savings in construction of new facilities would be the reduced cold-season fuel usage associated with the generation of bird heat. These savings would far exceed the additional cost of improved ventilation in high-density rearing environments.

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Lactic acid enhancement can improve the fresh and cooked color of dark-cutting beef

Issue

Dark-cutting (DC) beef is an economically relevant quality defect characterized by a pH value of 6.0, or higher, a shady dark-red to almost black lean color, a firm, "sticky" texture, and a very high water-holding capacity. More importantly, approximately 2 to 5% of the cattle slaughtered annually will produce DC beef, and it has been estimated that DC beef cost the American beef cattle industry between $170 to 750 million each year. Typically, DC beef is used as manufacturing beef or exported at substantial discounts because of its dark, unattractive fresh color and its persistent "raw" internal cooked color even when cooked to temperatures of 162°F ("medium" degree of doneness) or higher.

Action

In two experiments, beef strip loins (IMPS #180) from DC carcasses (ultimate pH values ranging from 6.5 to 6.9) were purchased from commercial beef packing plants and subsequently enhanced with solutions containing 0.15 (Exp. 1), 0.35 (Exp. 1 & 2), or 0.50% (Exp. 2) lactic acid (LA) at either 105 (Exp. 1) or 112% (Exp. 2) of the raw product weight. After LA-enhancement, steaks were cut from enhanced DC strip loins, non-enhanced normal pH strip loins (ultimate pH values ranging from 5.4 to 5.7), and non-enhanced DC strip loins. Fresh steaks were then packaged in a high-oxygen modified atmosphere before subjection to a 5-d simulated retail display. Additionally, all steaks were cooked to an internal temperature of 162°F before a trained sensory panel evaluated cooked beef color.

Impact

Enhancing DC strip loins with solutions containing 0.15 or 0.35% LA had little effect on fresh beef color during retail display, but effectively improved the cooked beef color similar to that of normal pH, low-Choice beef (Exp. 1). However, when DC strip loins were enhanced with 0.35% LA in Exp. 2, pH, visual and instrumental measures of fresh beef color, as well as cooked beef color, were numerically and statistically similar to that of normal pH, low-Choice beef. Even though texture and flavor profiles were affected by LA-enhancement, intensities of a number of specific flavors of steaks from DC strip loins enhanced with 0.35 and 0.50% LA were numerically similar to normal pH steaks. Thus, results of these two experiments indicate that LA enhancement can improve both the fresh and cooked quality attributes of DC beef, without detrimentally impacting beef palatability. These findings may someday lead to the reduction/elimination of the steep economic discounts associated with this quality defect that are received by today's cattle producers.

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Arkansas Beef Council; Division of Agriculture, University of Arkansas System

Making the grade: Effects of implants and age entering the feedlot on carcass 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 1 in 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 challenges 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—the fourth-ranked challenge facing the beef industry. Speculated reasons for the reduction in quality are among others: increased feedlot illness, aggressive implant regimes, and increased feeding of calves versus yearlings. The primary purpose of this study is to focus on animal age and implant status and their effects on carcass quality characteristics, tenderness, and eating quality.

Action

Cattle from the Southwest Research and Extension Center (SWREC) spring-calving cow herd, primarily of Angus ancestry (75 to 87% Angus), were weaned at 7 months of age and backgrounded for 63 d at the SWREC feedlot facility. Backgrounding diets were fed at a rate to promote average daily gain (ADG) of 2.5 lb/d. At the end of backgrounding one-half of the calves were sent directly to the Texas Tech University research feedyard for finishing and one-half remained at the SWREC for a 133-d grazing program prior to finishing as yearlings. Cattle finished as yearlings from the SWREC were placed on small grain pasture in December and removed at the end of March and sent to the Texas Tech University research feedyard for finishing. At the feedyard, cattle were fed steam-flaked corn-based finishing diets until the average backfat thickness for each group reached 0.6 inches. Additionally, one-half of each feeding group received an aggressive implant regimen, where cattle were implanted with hormonal growth implants at the beginning of backgrounding, at the start of grazing, at the initiation of feeding, and 50 d prior to the end of the finishing. The remainder of the cattle received a low potency implant regimen where the initial implant was delayed until 50 d prior to the end of finishing.

Impact

The aggressively implanted calves and yearlings groups gained bodyweight 15.5 and 17.6% faster than calf-feds and yearlings receiving low-potency implant program. Yearlings gained 10% more per day than calf-feds. Feed efficiency of calf-feds was improved by 18% with aggressive implant program and improved by 12% with aggressive implanting of yearlings. Calf-feds were 86 and 78% Choice quality grade with low-potency and aggressive implantation, respectively. Yearlings receiving low-potency implant program were 94% Choice, while yearlings receiving aggressive implant program were only 46% Choice. Age upon entering feedlot and implantation did not affect the amount of collagen, but aggressive implanting did decrease the fat content and increased the moisture content of loin muscle. Sensory panel analysis indicates that tenderness and juiciness are reduced with aggressive implantation. 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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Funding
Arkansas Beef Council; Division of Agriculture, University of Arkansas System

Effect of wheat forage maturity and preservation method on forage quality and performance of growing calves fed mixed diets

Issue

In the southeastern U.S., harvest of cool-season annual grasses for hay in the spring is often delayed by adverse climatic conditions. Maturity at harvest has a large impact on quality; as forages mature, concentrations of protein decrease, while fiber and lignin contents increase. Highly lignified forages remain in the rumen longer because of their slow rate of digestion, thus decreasing dry-matter intake (DMI), which reduces animal performance. Producers have increasingly turned to production of round-bale silage to improve the timeliness of harvest operations. The following research was designed to determine the impact of maturity at harvest (boot vs. dough stage of maturity) and preservation method (hay vs. silage) of wheat forage on forage yield and quality; as well as determine their impact on performance of growing calves fed mixed diets.

Action

Wheat forage was cut in the boot stage of maturity on 5 April, baled following 24-h wilt and wrapped for preservation as silage or allowed to cure and baled as hay on 17 April. Wheat forage was cut in the hard-dough stage of maturity on 14 May and baled following 6-h wilt and wrapped for silage or allowed to cure and baled as hay on 21 May. Forage harvested at the boot stage yielded 2,450 lb dry matter per acre and contained 15% crude protein and 58.7% total digestible nutrients. Forage harvested in the dough stage of maturity yielded 5,509 lb dry matter per acre and contained 8.9% crude protein (CP) and 57% total dry matter (TDM). During two feeding trials, the hays and silages were incorporated into diets containing (dry-matter basis) 20% (Trial 1) or 40% (Trial 2) roughage, and the primary concentrate sources were corn hominy feed and soybean hulls. The diets were fed in dry-lot pens to weaned growing beef steers and heifers for 63 d in Trial 1 and growing beef steers for 49 d in Trial 2.

Impact

Neither maturity at harvest or preservation method of wheat forage affected average daily gain, dry matter intake, or feed efficiency when fed in mixed diets containing either 20 or 40% roughage. Average daily gains averaged 2.65 and 3.99 lb/d in Trial 1 and 2, respectively; dry matter intake expressed as a percentage of body weight averaged 3 and 2.9% in Trial 1 and 2, respectively; and feed:gain averaged 6.7 and 4.0 lb of feed/lb of gain during the first trial and second trial, respectively. When fed in mixed diets, altering maturity at harvest and/or preservation method of wheat forage has no impact on animal performance or feed efficiency; this gives producers using these feeding programs a considerable window of opportunity for harvest in order to optimize forage quality and yield.

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Assessment of prolactin-promoter single nucleotide polymorphisms (SNP) as genetic markers for resistance to internal parasites in Angus cattle

Issue

The physical environment in Arkansas is ideal for the support of internal parasites in cattle. It is estimated that the economic detriment in Arkansas cattle due to internal parasites ranges from $25 to $200/head. This includes losses in cattle performance and the cost of providing anthelmintic treatment. Overuse and continued utilization of some of the

available anthelmintic products has led to development of resistance in parasites. It has also been reported that residues of anthelmintic chemicals have been found in food and the environment, indicating a need for methods of non-chemical parasite control. This might involve a compromise between performances in productivity traits and reduced chemical control. Research is needed to identify means of non-chemical control and to evaluate genetic resistance—perhaps the ultimate in sustainable parasite control. In conventional breeding programs, phenotypic selection for resistance could only be determined through exposure of the animal to internal parasites. The use of genetic markers for this trait could be useful in artificial selection.

Action

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

Impact

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

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Funding

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Poultry vaccinations against coccidiosis

Issue

Coccidiosis is a widespread disease of chickens caused by protozoan parasites of the genus *Eimeria* that has been estimated to cost the United States poultry industry approximately $733 million per annum. Currently, coccidiosis is controlled by the inclusion of anticoccidial drugs in the feed. The most widely used compounds are a class of drugs known as the polyether ionophorous antibiotics. Although these drugs are used for disease control, concerns have been expressed regarding their use in poultry feeds. There is an urgent need therefore to develop alternative methods of control such as by vaccination. Live vaccines are available for the control of coccidiosis, but in the U.S. these are not widely used partly because little information has been published on their efficacy. In order to achieve maximum efficacy, vaccination usually requires the administration of small numbers of the transmission stage of the organism (oocyst) in the hatchery. There is almost no published information, however, on the development of the immune response in chicks vaccinated in this manner. The present experiments investigated the development of immunity in chicks vaccinated with small numbers of *E. maxima*, one of the most widespread species that infects the chicken.

Action

Day-old chicks were immunized with a low dose (100 oocysts) of *E. maxima* and reared in floor-pens under conditions designed to simulate exposure to infection that might occur under commercial conditions. The development of the immune response was monitored by challenging them with larger doses at different times following vaccination. The results showed that, whether birds were reared on new or reused litter, excellent immunity developed by two weeks following vaccination. Clinical coccidiosis usually occurs in the field when birds are 3-5 weeks of age and thus, for this species, vaccination with a low dose of oocysts should provide adequate protection against coccidiosis.

Impact

The present results show that chickens can be vaccinated against coccidiosis by administering low numbers of oocysts immediately post-hatch. Considerable savings in the cost of vaccination can be achieved by giving small numbers of oocysts and by carrying out vaccination in the hatchery. The present results show that vaccination is a valid alternative to chemotherapy for the control of coccidiosis.

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Funding

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Lactobacillus preservative and baling protocol improve crabgrass-hay energy yields

Issue

Crabgrass is a warm-season annual forage that has greater nutritive value than most other warm-season grasses and is highly palatable, but curing time for crabgrass hay is typically longer than for bermudagrass. This causes producers to delay baling, which increases the risk of having the hay damaged from rainfall or increased exposure to sunlight.

Action

Crabgrass hay was either not treated or was treated with a lactic acid-*lactobacillus* preservative (LAL) and baled at two different moisture levels to determine those effects on forage intake and digestion by lambs, and ruminal digestibility by heifers. Field plots of crabgrass were assigned randomly to one of four treatment combinations such that half of the plots were sprayed with LAL at mowing and half were not sprayed (U). Within LAL and U, half of the plots were baled at 28% moisture and half at 18% moisture. These forages were evaluated for animal preference and digestibility using lambs, and for ruminal digestion characteristics using ruminally cannulated cows.

Impact

Treating crabgrass with the LAL preservative at the time of mowing improved dry-matter digestibility and digestible dry-matter intake. Lambs preferred crabgrass baled at 28% moisture over hay baled at 18% moisture, although the hay baled at 28% moisture had the appearance of greater heat and mold damage. The water-soluble fraction and effective ruminal digestibility were greater from crabgrass that was both treated with the LAL preservative and baled at 28% moisture. Therefore, treating crabgrass with an LAL preservative should result in greater energy intake and help ruminant animals meet a greater portion of their energy requirements from the hay rather than from purchased concentrate feedstuffs, which in turn may reduce overall feed costs.

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Tall fescue toxicosis mitigated with non-toxic, novel endophytes

Issue

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

Action

Both spring and fall-calving cows grazed either toxic tall fescue (E+) or a combination of 25% NE+ and 75% E+. Additionally, spring-calving cows grazing 100% NE+ served as a positive control. Cows grazing pastures with 25% NE+ were moved to NE+ for 2 months in the spring and 1 month in the fall during periods when E+ appeared to exert the greatest negative impact on cattle. We have completed the second year of a 3-yr study.

Impact

Fall-calving cows were heavier and had greater body condition scores (BCS) at breeding. In addition, 44% more fall-calving cows calved compared with spring-calving cows. Rotating both spring- and fall-calving cows from E+ to NE+ increased cow body weight, BCS, and calving rates. Calves weaned from 100% NE+ pastures weighed 75 lb more at weaning than the mean of spring- and fall-born calves grazing E+, and fall-born calves weighed 37 lb more than spring-born calves at weaning. Using Arkansas state average calf prices (weight adjusted) on the actual calf weaning date, the sale value for fall-born calves was $78.13 greater than that of spring-born calves. Replacing 25% of the E+ pasture area with NE+ resulted in a 17% greater calving rate and 23 lb heavier calves at weaning having a $15 increase in value. Based on two years of information along with previous research at the same location, fall-calving cows appear to be able to contend with E+ better than spring calving cows, resulting in greater calving rates and heavier calves sold on a seasonally higher market, resulting in greater calf value, particularly when expressed as a percentage of the total number of cows exposed for breeding. Converting E+ pastures to NE+ may not be necessary or economically viable if fall calving is an option for producers.

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Optimal 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 affect on male fertility and hatching egg production but limited work on female fertility has been conducted. Key factors that may affect female fertility during a production period may be weight, body composition and age. Dietary programs that provide optimal egg production are utilized for breeder hens because there is a lack of information suggesting different requirements for fertility.

Action

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

Impact

A 13% crude protein level in breeder I and breeder II diets would decrease the feed costs approximately 4 Dollars per ton and 25 cents per breeder during the production period. The feed costs per dozen hatching eggs could be lowered by approximately 2 cents per dozen and the number of fertile hatching eggs increased eight percent from an average of 145 per breeder to 159 hatching eggs. The increased number of hatched chicks per breeder could increase by 10 increasing revenue by $3.00 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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Funding
Cobb-Vantress, Inc., Siloam Springs, Arkansas; Division of Agriculture, University of Arkansas System; Arkansas Agricultural Experiment Station

Release and launch of Interactive Broiler Income Spreadsheet (IBIS)

Issue

Poultry production in Arkansas and the surrounding Ozark Plateau is undergoing fundamental change. Although technology and production economics are moving the industry toward fewer and larger production units, the predominance of operations with four or fewer poultry houses managed by part-time family farmers remains. Concerns about environmental quality, animal disease, energy costs, technological upgrades, and returns to investment are combining to add economic pressures to many producers' lists of concerns. Domestic poultry processors are also facing a wide array of pressures such as rising feed and energy costs, all of which may restrict their capacity to increase grower pay. There is growing concern that some segments of the industry may move off shore to reduce costs and improve competitiveness. In addition, the consolidation of the industry has left many rural communities with few sustainable or viable options for maintaining their farming heritage. Other communities have experienced rapid expansion of the industry with associated social pressures.

Action

The poultry industry has experienced unprecedented efficiencies since 1960 in large part due to vertical integration facilitated by production contracts between growers and integrators. As growers seek information about contract production they need to be well informed about all aspects of the process, especially net income and cash flow expectations resulting from more accurate expense and revenue estimates. The Interactive Broiler Income Spreadsheet (IBIS) was developed to enable current and prospective poultry producers (breeder hen, pullet and broiler grow-out) to better estimate income. IBIS, an interactive and unbiased Flash-based™ tool to assist in decision making regarding broiler production profitability, is capable of using either actual grower expense and revenue information or grower-panel default data to assess income under various grower-specified production, expense and price scenarios. Poultry integrator grower service personnel, lenders and Cooperative Extension professionals may utilize IBIS to assist growers in operational planning and risk-tolerance identification in varying economic situations. Growers may also gauge effects of capital improvements, equipment upgrades, chick placements and time between flocks on income. IBIS is updated periodically through collection of additional data and revision of procedures based upon field testing and is available on the University of Arkansas website.

Impact

The direct impact of the poultry industry in Arkansas is substantial. In terms of labor income, poultry production and processing accounted for $1.5 billion in 2003; 44,960 jobs were attributable to these activities and $2.7 billion in value-added were contributed to the state's economy by them. There are approximately 6,000 poultry farms in Arkansas operating around 15,000 houses. Planning and decision-making guides are particularly important now as propane approaches $2 per gallon and other energy costs escalate at alarming rates.

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Funding

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Development of a novel bacteria-vectored vaccine 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 that 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 AI on the bacterial cell surface. Due to the potential of the bacterial vector to cause infection, two virulence genes were deleted for attenuation purposes. The candidate vaccine strains were then used in experimental studies to determine serum antibody titers to the presented polypeptide, persistence of the vector within the host and ability of the candidate vaccine to protect against direct high- and low-pathogenicity AI challenge. In initial evaluations, the candidate vaccine demonstrates significant promise. This is especially true for those isolates that threaten the U.S. poultry industry each year.

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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Genetic analysis of selected traits in swine

Issue

Selection based on performance data may have important effects on other traits not included in the selection criteria due to genetic correlations among the traits of interest.

Action

Work continues on estimation of genetic correlations between performance test traits and subsequent reproductive performance in Landrace, Yorkshire, Duroc and Hampshire breeds of swine. Relationships between performance test traits and subsequent reproductive performance in first parity females in these breeds were examined.

Impact

Knowledge of the impact selection for one trait (or group of traits) will have on other traits (or group of traits) is needed by producers when developing selection programs.

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Effects of timing of vaccinations on newly received beef stocker calves

Issue

Bovine respiratory disease is the leading cause of morbidity and mortality in weaned beef calves. Calves purchased at local auction markets throughout the southeastern U.S. are typically classified as at high risk for developing symptoms of bovine respiratory disease because these cattle are of unknown origin and recently weaned from small, cow-calf

operations that seldom utilize vaccination or other bovine respiratory disease prevention strategies. These high-risk cattle may experience a combination of commingling, transport, nutritional, weaning and environmental stressors that can compromise the immune system, and the transportation stress period can endure for several days post-receiving. Vaccine efficacy may be reduced if administered during immunosuppression. Other complications with on-arrival vaccination may include reduced gain performance, perhaps due to immunological challenge from vaccine antigens during immunosuppression. Thus, our objective was to evaluate the effect of delaying by 14 days respiratory and/or clostridial vaccination on health and growth performance in high-risk beef stocker calves that were newly received from auction markets.

Action

Four protocols for vaccine administration were compared; they varied by when clostridial and modified-live respiratory virus vaccines were administered, either on arrival (day 0) or delayed until 14 d after arrival at the stocker facility. Two hundred and sixty three beef calves, that were newly received from auction markets, were given 1) arrival clostridial and respiratory vaccines; 2) arrival clostridial vaccine and delayed respiratory vaccine; 3) delayed clostridial vaccine and arrival respiratory vaccine; or 4) both vaccines were delayed until day 14. Calf body weight gain did not differ during the entire 56-day trial due to vaccination timing. Vaccination timing also did not affect the percentage of calves that required treatment with antibiotics for bovine respiratory disease. The timing of respiratory vaccination did affect antibody titers against bovine viral diarrhea, with greater levels earlier in calves administered respiratory vaccine on arrival.

Impact

Delaying vaccination for clostridial or respiratory diseases did not affect gain or health in newly received stocker calves. Calves administered the respiratory virus vaccine on arrival developed protective antibody titers to bovine viral diarrhea earlier than calves that received the delayed vaccination.

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Funding:
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Impact of crossbreeding dairy cattle in a commercial herd

Issue

The dairy industry has been quite successful at improving milk yield of cows—especially Holsteins—by selecting animals within a breed. In the United States the Holstein breed predominates, and semen is offered for sale at reasonable prices from a large selection of outstanding bulls. Producers may also select semen from several Jersey bulls, but few bulls are available from other breeds. Other traits that respond to selection within a breed have also improved. However, traits that affect reproduction or structure of feet and legs (as examples) are not very heritable and reduce the longevity of cows. These traits would respond to crossbreeding, but more intense selection would likely be required to maintain milk yield and other traits of economic importance. While producers of other animal species have successfully employed crossbreeding for producing the animals needed; in the dairy herd the producing cow is also the animal that is needed for reproduction. So, some producers are attempting to outcross within the breed by acquiring semen of Holsteins from other countries. An alternative is to crossbreed Holstein cows to bulls of other breeds that are adapted to conditions in the United States.

Action

Three breed groups of heifers were born at a dairy farm in central Texas. Healthy heifers were selected at about 6 mo of age for development and breeding at the University of Arkansas farm in Fayetteville. The heifers were returned to the farm in Texas approximately 6 wk before calving (at about 22 mo of age) and initiated their first lactation between January 1998 and June 1999. Lifetime production rates (148 lactation records) of 15 Holstein, 14 Holstein x Brown Swiss, and 20 Holstein x Jersey cows were obtained after being returned to the commercial herd.

Impact

Breeding efficiency of the crossbred heifers was improved compared to Holstein heifers, and as cows they tended to have fewer days in milk than Holsteins indicating that the improved breeding efficiency documented as heifers may have persisted as the cows matured. During the first lactation, Holstein cows tended to produce more milk (21,069 lb) than their crossbred herdmates (18,352 lb for Holstein x Brown Swiss and 17,743 lb for Holstein X Jersey cows), but means were similar for breed groups in lactations 2 and 3. Holstein x Jersey cows remained in the herd longer than Holstein cows (3.3 vs. 2.8 lactations) and produced more lifetime pounds of milk protein than the other breed groups.

In summary, crossbred cows performed well compared to Holstein herdmates in a commercial herd, and the Holstein x Jersey crossbreds persisted longer in the herd.

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Biotechnology and functional genomics in viral disease control in poultry

Issue

Avian viral diseases, including infectious laryngotracheitis virus (ILTV; gallid herpesvirus 1), cause economic losses in poultry industries by decreasing productivity. The control of viral diseases is of the utmost importance to maintain poultry productions safely. Though various vaccines produced by virus attenuation using chicken eggs or primary tissue cultures have been used efficiently to protect poultry flocks, the vaccination efficacies were varied depending on vaccine types, pandemic strains, and immunization methods. Therefore, the technical improvement to produce efficient vaccines more rapidly is required to minimize the loss in poultry production. In addition, recent development of functional genomic techniques, including microarray analysis, enabled the realization that genome-wide screening methods to identify differentially expressed genes can be powerful tools to understand host regulatory pathways in host-virus interactions. Furthermore, the host regulatory elements can be utilized to control viral disease. Recently, herpesvirus encoding microRNAs have been characterized in the regulation of gene expressions for both virus- and host genes during viral pathogenesis.

Action

Arkansas scientists are currently conducting studies on the construction of bacterial artificial chromosome (BAC) clone for ILTV genome for further mutagenesis study to find a potentially attenuated strain. And, to provide a stable cell substrate for ILTV vaccine propagation, cellular immortalization studies are being performed with chicken embryo cells using a variety of molecularly expressing constructs. These studies result in at least two immortal cells lines being established for ILTV propagation. In addition, the microarray analysis is being newly utilized to investigate differentially expressed host genes in the process of ILTV pathogenesis. From this work, 791 differentially expressed genes were identified during ILTV replication. Lastly, ILTV encoding microRNAs, which may regulate expression of both viral- and host genes, were identified and the functional roles are being characterized in the translational inhibition of gene expressions.

Impact

Production of a genetically engineered vaccine through biotechnical methods and the use of stable cell culture substrates should enable manufacturers of biological vaccines to assure better control over production processes, increase product safety and consistency, and ultimately reduce costs. In addition, if this new vaccine strategy is combined with the knowledge of host-virus interactions gained by functional genomic techniques, an ideal tool would be established to control viral disease more efficiently. Currently, the control of ILTV in Arkansas is estimated to cost the in-state poultry industry more than $3 million annually (from a casual survey of industry and academic veterinarians). The proper control of this important field virus could protect the poultry production system from possible immediate and staggering losses that can be caused from the actual outbreak to restrictions on international export of poultry from Arkansas.

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Bovine DNA analysis identifies promoter gene region involved in reproduction

Issue

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

Action

We have succeeded in isolating the promoter (control) region of the bovine beta follicle stimulating hormone (FSH) gene from bovine genomic DNA. We have created truncated segments of the control region and inserted the sequence into a plasmid vector that can be transfected into mammalian cells in order to study its functions. We are also using DNA sequencing in these promoter regions to identify single nucleotide polymorphisms that may be related to reproductive function as well as other functions.

Impact

FSH is one of the two gonadotropins that are essential for successful reproduction in all animals. An understanding of the control of FSH production at the level of the gene will enable a better understanding of the control of reproductive function in animals and provide the potential for the development of tools or methods to control or 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. In addi-

tion, the identification of single nucleotide polymorphisms (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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Gene markers identified in ascites-resistant broiler lines

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 and five polymorphisms in a second gene that occur with much higher frequencies in resistant broiler lines than in the susceptible lines. The collection of additional data has verified these results for at least one of these genes. These markers could be very important in developing selection tools to help select broiler lines that are naturally resistant to ascites.

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Immune-response genetic markers sought 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.

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.

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Accurate genetic surveys of parasites can aid bovine parasite-control programs

Issue

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

Action

We are using a technique developed by USDA scientists to identify the larval stages of major cattle parasites through the extraction of parasite DNA and the identification of sequences that are unique to specific organisms. 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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Improving cool-season forage assimilation may improve bovine reproduction

Issue

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

Action

A series of trials have been 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 artificial insemination (AI) and did not affect conception rates to AI. The complete data from this study are being summarized for publication.

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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 (WHO) in more than 46 countries for animal cases and in 14 countries for human cases with 393 people infected and 248 mortalities 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, eradicate infected animals, and then 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 the target virus and used in the sampler to separate and concentrate the 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 bio-nanobead-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 not 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 not any in-field AI test instrument available, this biosensor would provide the poultry industry with a very 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.

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Influence of organic minerals on gilt growth performance, claw growth, locomotor problems and subsequent reproductive performance

Issue

Sows' mineral reserves have been shown to decline over several reproductive cycles and depletion is exacerbated when sows support larger litter growth rates. Possibly exacer-

bating this reduction in reserves are suspected interactions between a trace mineral and other minerals or nutrients, which may decrease mineral availability or utilization by the animal. A decline may lead to marginal mineral deficiencies that may affect growth, reproduction, and health, but otherwise have no outward signs. The premise for using organic trace minerals in animal diets and replacing traditional inorganic sources is that their bioavailability is greater because they remain stable in the digestive tract and do not form insoluble chelates with other dietary components. Organically bound minerals ("organic minerals") have been developed in recent years as dietary alternatives to traditional inorganic sources and are termed metal-chelates, complexes, or proteinates. Studies comparing inorganic and organic mineral sources on reproduction have provided conflicting results and additional research is required to clearly establish the role of organic minerals for improving the reproductive efficiency of high-producing sows.

Action

A total of 368 maternal line gilts (GPK35) from 15 groups of gilts delivered to the University of Arkansas research facility were used in this study to evaluate the effect of organic minerals (Zn, Cu, Mn and Cr) on gilt growth performance and claw wall growth as well as subsequent reproductive performance. Sows fed complexed minerals had heavier litters at birth compared to sows fed inorganic minerals (18.89 vs. 18.07 kg), although number born alive was not different (13.37 vs. 12.89 piglets). In addition, sows fed complexed minerals weaned heavier litters than sows fed the control diet (67.15 vs. 63.73 kg), while number weaned was not different (10.74 vs. 10.53 piglets). This response is likely attributable to the fact that sows fed complexed minerals consumed more total feed during lactation than sows fed the control diet (118.9 vs. 111.9 kg). Sows and gilts fed complexed minerals also had lower walking scores as evaluated by three trained technicians indicating that soundness may be improved by feeding organic minerals.

Impact

This research was conducted to address questions concerning the efficacy of feeding more expensive organic minerals to the sow herd. Although, mineral source did not impact growth performance or claw wall growth in developing maternal line gilts, feeding organic minerals did improved litter birth weights and weaning weights, and enhanced feed intake during lactation.

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Small bird programs: Impact of phase-feeding and strain on growth performance, yield, fillet dimension, and meat quality of broilers

Issue

Meat and carcass quality are very important issues in the poultry industry because of the relation to consumer acceptance, labor issues, and profits. Specifically, tenderness of early-harvested broiler breast meat and product uniformity are primary concerns. Moreover, the industry is always interested in lowering production costs. Phase feeding (PF) is a regimen that has been shown to reduce production costs and slightly improve product uniformity, without negatively impacting growth performance or carcass yield. However, phase-feeding research has been limited to a single strain of male broilers and further research is needed to evaluate its impact on various strains in straight run production systems. Therefore, the purpose of this study is to evaluate meat quality and uniformity of broilers from genetic strains representing different growth patterns to determine the effect of genetics and phase feeding on these quality traits of birds processed for the small-bird market segments in today's commercial environment.

Action

Commercial broilers representing multiple genetic strains in industry (3 strains for the small bird market) were raised and processed at a common market age for the small bird market (day 40) using standard commercial practices. Broilers were fed a diet consisting of a typical industry program or a phase feeding regimen. Growth performance will be assessed. Broilers were processed and deboned at 2, 4, and 6 h postmortem. Fillets were subjected to footprint analysis, shear, muscle pH, color, drip loss, and cook loss analysis. Assessments on product uniformity were conducted. Differences among strain body weights were noted throughout growout at d 0, 18, and 32. Weight gain, feed intake, and feed efficiency were affected by strain, and these parameters were improved by PF. Strain, gender, and debone hour had significant effect ($P < 0.05$) on fillet dimensions (FD). There were no differences in FD due to PF; however, uniformity was improved (indicated by SD and CV). Strain and PF treatment did not affect pH, color, cook loss, or MORS.

Impact

These results suggest that different strains may vary in their response to phase feeding though performance was improved in each strain. Phase feeding may be effective at improving uniformity, but this response may be dependent on strain and gender. The results of this study also suggest phase feeding does not adversely affect yield or meat quality of broilers in small-bird programs regardless of strain.

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Impact of genotype on carcass, meat quality, and sensory attributes for turkeys raised with outdoor access

Issue

Consumer interest is growing in specialty poultry markets, including natural and organic, which may feature alternative genotypes and production systems. Alternative turkey genotypes include "heritage breeds," which are slow-growing standard breeds that mate naturally, and alternative production systems include outdoor access and natural feeds. Consumers buy specialty products for reasons such as nutrient/sensory attributes and animal welfare.

Action

A trial was conducted to assess the impact of alternative genotype on parts yield, meat quality, and sensory attributes. A commercial fast-growing genotype (Fast) and a slow-growing genotype (Slow) (all females) were raised for 14 weeks and 24-28 weeks, respectively. Forty turkeys of each genotype were raised on a small commercial farm in a naturally-ventilated shed with access to outdoor yards and were provided the same diets. Turkeys were processed at a small processing facility and stored at 33°F. Sixteen turkeys of each genotype were deboned at 2 d postmortem for meat quality analyses. A descriptive analysis of fresh breast and thigh meat of Fast and Slow birds was conducted by a trained panel, while a consumer analysis included an additional treatment, a retail turkey. The carcasses of the Fast turkeys were larger than those of the Slow turkeys. The breast yield was higher for the Fast compared to the Slow, while the leg yield was higher for the Slow. The breast meat of the Slow had lower pH and was less pale and more red than Fast. The descriptive panel found few differences in the flavor of breast meat, although the Fast had more intense cooked meat flavor and the Slow had more intense aftertaste of blood/metal. The panel found more differences in texture. The Slow was more hard, cohesive, and fibrous than the Fast. However, in an instrumental study, the Slow was more tender than the Fast. In most categories of the consumer trials, the Retail and Fast were preferred over the Slow, including appearance and texture. For the breast meat, the overall preference was higher for Retail than Fast and Slow, and the preference of flavor was higher for Retail than the Slow.

Impact

These data indicate differences in meat quality and sensory attributes, especially in terms of texture, with consumers preferring the conventional turkeys over the specialty.

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Strategies for cost-effective clover establishment

Issue

Major obstacles for introducing legumes to beef farms include expenses and space restrictions for establishing legumes on pastures currently in production. 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 overseeding 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, 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 two additional replications during the following years.

Impact

Preliminary results suggested that at a high seeding rate of both crimson and white clover, seedling emergence is most successful when a no-till drill is used. Under this scenario, the pasture canopy must be short to ensure most efficient use of expensive inputs. However, when seeds can only be broadcast, then it may be advantageous to graze after seeding to foster seed-to-soil contact through hoof action. This might also be a long-term strategy to establish small areas at a time and expand to other areas of the farm during subsequent years. Findings from our research will be 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 substantially lower nitrogen fertilizer costs associated with beef production.

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Funding
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Evaluation of ivermectin and long-acting moxidectin in the development of replacement beef heifers

Issue

Parasitism is a widespread problem, and it negatively affects cattle production in Arkansas. Parasites can lead to reduced feed efficiency, decreased feed intake, gastrointestinal tissue irritation, and overall reduced performance. Parasiticides (anthelmintics) continue to be used as the foremost treatment against bovine parasites. Recently, new formulations of long-acting anthelmintics have been manufactured for use in beef cattle. These products have been reported to possess extended effectiveness against internal parasites of cattle. The objective of this study was to assess the efficacy and benefit of ivermectin and long-acting moxidectin in the development of replacement beef heifers.

Action

A study was conducted by the University of Arkansas Department of Animal Science on naturally infected replacement beef heifers (n=105) for 433 days. The heifers were evenly and randomly allocated to one of three treatments: long-acting moxidectin injectable (MXD), ivermectin injectable (IVO), and a negative control (CON). Treatments were administered on d 0 and d 149 of the study. On d 175, all heifers were exposed to fertile bulls during an 84 d period. Pregnancy status was subsequently determined with the use of transrectal ultrasonography. Treatment group body weights, egg counts and coprocultures were similar between groups on d 0. Egg counts were lower ($P < 0.05$) for MXD-treated calves on d 14, 64, 149, 169, 238, and 287 compared to the other two groups. Egg counts for the IVO group were lower ($P < 0.05$) than CON counts on d 14 and 169, which were sampling dates approximately 14 days following treatment dates. Body weights were higher ($P < 0.05$) for both MXD and IVO groups compared to the CON group from d 149 through d 433. ADG was greater ($P < 0.01$) for MXD and IVO compared to CON from d 0 to d 433. No treatment effect was identified on pregnancy status with an overall pregnancy rate of 93%.

Impact

Replacement heifers treated with long-acting moxidectin and ivermectin had superior average daily gains as measured from d 0 to d 433 when compared to negative controls. Based on fecal egg counts, long-acting moxidectin exhibited superior efficacy and extended activity against intestinal nematodiasis when compared to ivermectin and a negative control. These results indicate more efficient performance can be expected when utilizing anthelmintics during the management of replacement beef heifers. The data from this field study will be presented at the 2009 annual meeting of the Southern Section of the American Society of Animal Scientists. More research should be conducted to continue the investigation of parasite control with the use of long-acting products.

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Funding
Division of Agriculture, University of Arkansas System

Bovine DNA-based fertility research may yield greater calving rates

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 percent. Obviously, reproductive success in a cow herd is dependent on both fertile cows and fertile bulls. Weaning weights and scrotal circumference are typical selection criteria for bulls, and have been associated with their daughter's fertility. However, in some cases the predicted daughter success is not realized.

Action

Using candidate genes we have identified single nucleotide polymorphisms (SNPs) that are related to fertility and calving rates of beef cows. In one case, we have identified a SNP allele in the upstream elements of the heat shock protein gene that is associated with heavier weaning weights and larger scrotal circumference of bulls, and associated with decreased calving rates of cows. That SNP could be very useful in selecting bulls that will sire heifers that will mature into cows with high fertility. 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. The 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; Division of Agriculture, University of Arkansas System; Arkansas Agricultural Experiment Station, Animal Health Formula Funds; National Research Support Project, NRSP-008; Multistate project, W-1171 SERA-IEG 8

Whole-farm profitability of conservation tillage with winter small-grains forage production in Arkansas

Issue

Winter grazing of stocker cattle on small grains pastures may be a profitable income option for cattle producers in Arkansas. Cow-calf operations account for the majority of cattle operations in the state, with most calves born in the spring and sold at weaning in the fall. Winter small-grains forage production may allow some cow-calf operators to retain ownership of their calves beyond the fall or purchase additional calves to be sold in the spring when the winter pasture is grazed out. However, a large portion of land that could potentially benefit from this production system is highly erodible. Also, production of winter small-grains forage requires additional machinery and equipment that may not be available on most Arkansas cattle farms. This study evaluates the profitability of conservation tillage winter wheat/rye pasture production and grazing for a 100-head cow-calf operation. The study uses Mixed Integer Programming (MIP) to maximize whole-farm returns and select the optimal machinery complement for hay and winter forage production.

Action

A 100-head cow-calf operation is modeled using secondary data sources. The model cow-calf operation has 250 pasture acres and harvests it own hay. A stocker enterprise is modeled for the cow-calf operation to allow steers to be grazed on winter wheat/rye pasture from mid-November through April using steer weight gain data from the University of Arkansas Livestock and Forestry Branch Station (LFBS) near Batesville. Steer calves in the stocker enterprise are grazed both in the fall and the spring. During the fall grazing period, steer calves from the cow-calf operation may be retained and placed on grazeout pasture with additional steer calves purchased as needed to fully utilize fall grazeout pasture. Additional steers may also be purchased during the spring grazing period to fully utilize spring grazeout pasture capacity. All additional steers are purchased using borrowed capital at 9% interest. The MIP model selects optimal machinery complements for both hay production and winter small grains forage production. Three possible systems are allowed for winter small-grains forage production: Clean-Till (CT); Reduced Till (RT); and No-Till (NT).

Impact

The results provide evidence that grazing stocker cattle on no-till winter small-grains forage can enhance profitability for a cow-calf operation. The NT method is always chosen as the optimal method of winter small-grains forage production, and the farm operator may hold steer calves beyond weaning and graze them on winter grazeout pasture for sale in the spring rather than in the fall. However, the whole-farm profitability of grazing stocker cattle on no-till winter small-grains forage appears to be highly dependent on the amount of capital available for purchase of additional steers. Additional steers must be purchased with borrowed capital to fully utilize available winter forage capacity and achieve maximum returns. Thus the practice may not be profitable in instances where cow-calf operators lack the necessary capital to purchase additional steers.

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Funding

NRI Competitive Grant; Division of Agriculture, University of Arkansas System

Pulmonary hypertensive responses of broilers to bacterial lipopolysaccharide (LPS) administered by aerosol, intratracheal, or intravenous routes

Issue

Bacterial lipopolysaccharide (LPS, endotoxin) is an integral component of the cell wall of Gram-negative bacteria (e.g., *E. coli* and *Salmonella*). Broiler chickens in commercial production facilities chronically breathe air-borne LPS that can trigger respiratory inflammation and pulmonary arterial hypertension (PAH; an elevated blood pressure within the pulmonary arteries). Previously we demonstrated that broilers reared on new wood shavings litter in clean environmental chambers did not develop PAH in response to an aerosol spray of LPS, whereas broilers raised under less sanitary commercial conditions did develop PAH in response to aerosolized LPS. Pretreatment with aerosolized organic compounds also "primed" or "sensitized" the broilers' airways and permitted aerosolized LPS to elicit PAH. We now report the results of additional studies that were conducted to determine if aerosolized organic compounds cause immune cells to migrate into the airways, thereby sensitizing broilers to the subsequent development of amplified PAH responses to inhaled LPS.

Action

Broilers reared on new wood shavings litter in clean environmental chambers either remained untreated (Control group) or were exposed for 40 min to aerosolized FD&C Red Dye # 3 dissolved in propylene glycol (Red#3+PG group). Inhaled Red Dye #3 previously was shown to sensitize the respiratory responsiveness of broilers to LPS. Twenty-four hours later a blood sample was taken, the broilers were humanely euthanized, and a pulmonary lavage procedure

was used to collect the immune cells inside the airways. Leukocyte concentration and differential leukocyte counts were measured in blood and lavage fluid. The percentage of blood lymphocytes was lower in broilers from the Red#3+PG group compared to birds from the Control group. Cells recovered from the lavage fluid from both groups were primarily heterophils, and the concentration of leukocytes was higher in the lavage fluid of broilers from the Red#3+PG group compared to broilers from the Control group. Migration of immune cells from the blood into the airways appears to be one of the components that enables "primed" or "sensitized" broilers to exhibit amplified PAH responsiveness to intratracheal LPS.

Impact

We are developing an experimental model that will permit us to evaluate extrinsic (environmental) and intrinsic (genetic) factors contributing to differences in the responsiveness of broilers to inhaled LPS. Broilers that are better able to tolerate aerosolized LPS should be capable of superior performance in commercial broiler production facilities.

Contact

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Funding

Division of Agriculture, University of Arkansas System; Animal Health Grant "Respiratory Response of Broilers to Inhalation of Bacterial Lipopolysaccharide (LPS, endotoxin): Development of an Aerosol Inhalation Model and Characterization of Vasoconstrictors Contributing to PAH"

Prevalence, dynamics, and control of gastrointestinal helminth parasites of farm animals

Issue

Parasitic helminths are omnipresent pathogens which reduce animal health and producer profits. Constant vigil must be directed toward their surveillance and the development of better controls.

Action

Studies into the dynamics and control of gastrointestinal helminths of poultry and cattle were conducted in 2008. Helminth parasitisms of farm animals are omnipresent and usually subclinical, exacting a loss primarily in animal productivity and owner profits. Status of the parasitisms (levels, resistance, etc) must be assessed continually, as these pathogens continue to adapt to all selection pressures in their environment [drug use, global warming, changes in husbandry (organic farming), etc]. In regard to poultry, we conducted two projects with insightful results. In chickens, we documented the effectiveness of a new fenbendazole formulation. Removal of Raillietina cesticullus infections was accomplished at >90% at a dose rate of 60 mg kg^{-1} BW; a finding that collaborates with work we did several years ago as fenbendazole was initially being reviewed for commercial clearance. Obviously, resistance has not emerged in poultry tapeworm populations. In turkeys, commercial levels of dietary nitarsone were found to completely restrict reproduction by Ascaridia dissimilis. This is the first scientific documentation of this activity. In cattle, we continued to document the lack of efficacy by generic compounds, parasite and stage-specific lack of efficacy for ivermectin, and excellent, broad-spectrum efficacy for moxidectin.

Impact

From all the above studies, incidences of various parasitisms of chickens and cattle were documented, as well as effective means of control. With these findings, greater control of parasitisms will be realized, along with improved animal health and productivity.

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Funding

Division of Agriculture, University of Arkansas System; Intervet; Fort Dodge Animal Health; Alpharma; Merial, LTD; Charles River Pharmaceuticals

Plant Systems

Consequences to seedling vigor from seed damaged by rice stink bug

Issue

Rice growers know that grain damaged by rice stink bugs can influence grain quality and cause discounts when excessive amounts are present. What is not known is whether damaged grain has an influence on performance of seed a grower may keep to plant or seed purchased from a seed dealer. Rice stink bug adults and nymphs feed on rice kernels at all stages of development except at hard dough and mature grain. After the hull is pierced by the rice stink bug, fungi gain entry and the infection results in a discoloration of the kernel. The amount of damage by rice stink bugs influences the acceptability and value of rough rice. But, stink bug damage could also be of a major importance to growers and seed dealers if damaged grain have an influence on the performance of seed destined for planting.

Action

A study was initiated to access the influence on seed germination and seedling growth of seed damaged by rice stink bug. Categories of damage were based on the amount of discolored area visible on grain as defined by the light box. Categories were: (1) undamaged; (2) <10% (3) 25% (4) 50% and (5) 75% of kernel (endosperm) that did not include the germ; and 6) damaged germ. If any seed in a category germinated, the seeds were planted in potting soil and plants were allowed to grow for 14 days after emergence from the soil. Results showed that feeding damage had a negative influence on seedlings. An average of 86% of all damaged seed, as selected by the light box, was at or near the germ. There was no germination in seed where damage was at or near the germ. Germination was 80% in seed with 50 and 75% damage. Also, as the amount of damage to a seed increased, the amount of time to germinate increased, seedlings were shorter in height, had less foliage, and roots were less numerous.

Impact

Seed dealers and growers now have information on the influence of damage by the rice stink bug on the performance of seed rice. Of noteworthy importance is that not all damaged seeds are light weight and are not removed by post-harvest cleaning procedures. Many damaged seed remain that will adversely affect seed germination, vigor, seedling size, root volume, and seedling competitiveness.

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Arkansas Rice Research and Promotion Board; Rice Research and Extension Center, Division of Agriculture, University of Arkansas System

Arkansas cotton germplasm lines provide improved yield components, fiber properties, and host-plant resistance

Issue

Over the past five years, 32 germplasm lines have been released by the University of Arkansas cotton breeding program. These lines have generally displayed enhanced host-plant resistance, improved yield, earliness, varied morphological traits, and/or enhanced fiber properties. Several of the releases have led to the development of privately owned varieties that are highly adapted to Arkansas conditions. Continued development and release of cotton lines will help Arkansas cotton producers to have adapted, competitive varieties.

Action

The Arkansas Agricultural Experiment Station released three cotton germplasm lines in 2008. The three lines were derived from crosses made in 1997 followed by development and testing. Each line was selected for high yielding capability (multiple in-state and regional tests), yield stability (via yield components), resistance to specific pests, and fiber quality.

Lint yields of Arkot 9704 and Arkot 9706, which were equal to two check cultivars 'PSC 355' and 'SG 105', could be attributed in part to higher lint per seed (and lint fraction) produced by fewer seed per area than either check cultivar. More stable, efficient production should be produced by this combination of yield components. Lint yields of Arkot 9721 were about 10% lower than the check cultivars, but lint per seed of Arkot 9721 was equal to the checks. Fiber properties of Arkot 9704 and Arkot 9706 tended to be similar to the check cultivars, while Arkot 9721 expressed improved fiber length, length uniformity, and micronaire.

Leaf pubescence and marginal bract trichome density of Arkot 9704 were lower than either check cultivar. Arkot 9706 was similar to SG 105 and Arkot 9721 was intermediate to the two check cultivars for these traits. All three lines expressed resistance to bacterial blight. Arkot 9704 and Arkot 9721 expressed resistance to tarnished plant bug equal to PSC 355, while Arkot 9706 expressed higher resistance

than either check cultivar. The relative yield, fiber properties, and line-specific host-plant resistance traits make these lines valuable to cotton breeding programs.

Impact

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

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Funding

Cotton Incorporated; Division of Agriculture, University of Arkansas System

Alternative residue-management practice effects on soil moisture and soybean production

Issue

Degradation of surface-water quality from non-point source pollution is an important environmental concern for many people in areas that rely heavily on surface water as their main drinking water supply. This is a particularly critical issue in northwest Arkansas, where Beaver Lake is the main drinking water source for hundreds of thousands of people in an area that is experiencing rapid population growth and urbanization. Therefore, it is essential to evaluating the impacts of human-related activities on streams in the Beaver Lake watershed to maintain and improve high-quality, surface waters and adequately manage the various land uses within the watershed.

Action

To address this regional water quality issue, a study was initiated to evaluate the effects of season (dry/cool and wet/warm) and riparian land use (urban, grazed pasture, ungrazed pasture, wetland, cultivated agriculture, and grassland) on surface water quality in Research Creek, which flows through the Watershed Research and Education Center at the Agricultural Experiment Station in Fayetteville. Water samples were collected twice a month at sampling points within each riparian land use during base-flow conditions from October 2006 through October 2007. Water samples were also collected periodically during storm-flow conditions from October 2006 through December 2007.

Impact

Based on study results, it is clear that the land uses adjacent to Research Creek are having a significant impact on in-stream water quality with in-stream grazing appearing to have the greatest impact. In-stream concentrations of soluble-reactive phosphorus (SRP) in Research Creek are also somewhat alarming. The maximum measured SRP concentration was 40 times greater than the maximum SRP reported in other Ozark Highland streams and the average was 10 times that recommended by the EPA to reduce accelerated eutrophication in rivers and streams. Significant increases in SRP and nitrate-nitrogen concentrations from the inflows to the outflow averaged across flow regimes indicate that more SRP and nitrate-nitrogen are exported from this stream reach than are imported. Results of this study demonstrate the significant impact of adjacent land use on in-stream water quality of Research Creek and emphasize the significance of properly managing upstream land use in order to maintain downstream water quality.

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Funding

Bumpers College of Agricultural, Food and Life Sciences; Division of Agriculture, University of Arkansas System

Long-term residue-management practice effects on soil properties and crop production

Issue

Increasing carbon dioxide and other greenhouse gas concentrations in the atmosphere and the resulting rise in global air temperatures and finding alternative sources of fuel energy are two present-day global issues that are closely related to agriculture. Burning crop residues and excessive tillage of soil for many consecutive years are two agricultural management practices that directly affect these two global issues. To strive towards and/or achieve long-term sustainable crop production without significant negative impacts to the environment, the long-term effects of burning, tillage, and potential alternatives need to be studied.

Action

To address the need for identifying alternative residue and soil management practices that will likely be more sustainable than present practices, a long-term study was initiated in Fall 2001 to address the impacts of alternative residue management practices on near-surface soil properties and crop production in a wheat-soybean double-crop production system on a silt-loam soil in eastern Arkansas. Treatments investigated include conventional and no-tillage and residue burning and non-burning.

Impact

Based on the first six years of data collected in this long-term study, alternative residue management practices have the potential to accumulate organic matter and carbon in the soil and maintain similar crop productivity to conventional management practices. Implementation of the appropriate residue management practices has the potential to improve soil quality and maintain long-term productivity of silt-loam soils in the Mississippi River Delta region of the mid-southern United States.

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Funding
Soybean Research and Promotion Board; Division of Agriculture, University of Arkansas System

Soybean seed quality an expensive issue in Arkansas

Issue

According to Arkansas soybean farmers, soybean seed quality has been a growing issue with unexpected stand failures and expensive replanting when time is short in summer. Soybean seed prices have increased rapidly in recent years as a result of GMO trait technology fees, making this a more sensitive subject. Seed quality of the 2007 crop was suspect, due to extremely hot, dry weather in August in the Mid-South and the Midwest, where most seed was produced. Dumping of low-quality seed led to a seed shortage, so farmers had to scramble into the spring of 2008 to find seed to buy.

Action

At the request of the Arkansas Soybean Promotion Board, scientists in the Division of Agriculture Department of Plant Pathology and Crop, Soil and Environmental Sciences established a comprehensive research and extension project in April 2008 on soybean seed quality. The project also enlisted the help of experts in other states. For the first year, a major effort was to establish a research seed testing lab in Fayetteville and hire a seed analyst; both were accomplished in June. And, a statewide planting seed survey collected 445 samples from 41 counties from April thru July. These samples were tested by three labs for standard germ and seed vigor (as measured by the accelerated aging test) and stand establishment in sampled fields was recorded. The group produced a brochure explaining soybean seed quality and distributed 2000 at various meetings.

Impact

Results showed that standard germ and accelerated aging (AA) values obtained for the same samples tested by different labs were well correlated. The standard germ value, required on seed labels, did not change much among these samples over time while the AA values declined. Stand results showed that poor or failed stands did not correspond well to standard germ but were associated with samples having lower AA values, especially in June and July plantings. These results showed that standard germ was of limited value in estimating seed quality when planted late. Preliminary advice provided to growers as a result of this project were to: ask for all available information about seed lots being purchased, especially seed vigor; try to determine the vigor of purchased seed lots as close to planting as possible, even if it means having seed tested again; for seed not possible to test in time because of late delivery, a small sample should be kept in a seed sample bag in an air-conditioned room until stand establishment can be determined. If the field has a poor stand, the sample can be tested to determine if seed quality was a factor. At presentations during the summer and fall, growers and consultants expressed intense interest in this topic and these results. They estimated savings of $25 - $60 per acre if they could consistently avoid replanting and related costs and most importantly, less wasted time. This was especially a concern for June and July plantings, when time is short and weather not always cooperative.

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Cooperators
Ohio State University; Kentucky Dept. of Agriculture; Arkansas State Plant Board; University of Kentucky

Funding:
Arkansas Soybean Promotion Board; Division of Agriculture, University of Arkansas System

New soybean cultivars offer growers high productivity and profitability

Issue

Soybean is an important commodity in Arkansas and ranks on 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 System's Division of Agriculture soybean breeding program and have had significant impact on Arkansas soybean production. Growing a high-yielding variety does not cost more than growing an average variety.

Every bushel of extra soybean yield produced by growing the high-yielding variety is a net income to the growers. Higher yields from new and improved varieties should translate into higher profits to Arkansas soybean producers, particularly when productions costs are high. Varieties with disease resistance and stress tolerance will also prevent yield loss under unfavorable production conditions. In addition, public programs supply thoroughly tested varieties with low cost seeds that can be saved for planting, which provides additional savings for the growers. Three new conventional varieties (Osage, UA4805, and Ozark) have been recently released to the public. They all have high yield potential, good disease resistance, and excellent local adaptation. Foundation seeds are available for commercial production. Growers can also get certified seeds from local seed dealers.

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Funding

Arkansas Soybean Promotion Board; Division of Agriculture, University of Arkansas System

Specialty soybeans add value to the farm

Issue

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

Action

The expanding soybean-based food market in Japan and the U.S. has generated considerable interest among soybean producers. The demand for food-grade soybeans has been increasing due to the proved and publicized health benefits and nutritional value from soyfood products such as tofu, natto, soymilk, soysauce, miso, soynuts, edamame, and bean sprouts. A new breeding program has been initiated at the University of Arkansas in an attempt to develop high-yielding specialty varieties with improved seed-quality traits. We focus on breeding and selections for proper seed size, high protein, low fat (low-linolenic acid and mid-oleic acid), proper sugar and calcium content, soft texture, high isoflavone, and lipoxygenase-free quality. 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 biodiesel 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 $1.50 to $3.00 per bushel as incentives to produce the specialty seeds. The high-quality food-grade soybeans, produced conventionally or organically, are often sold at a much higher price than regular commodity soybeans. Therefore, every bushel of extra yield would not only generate extra net income from soybean sales, but also gain additional production premiums. In addition, farmers can save seeds from their own crop harvest for planting next season, thereby ensuring identity preservation and reducing/eliminating seed costs. The specialty soybeans will play an important role in expanding the niche markets for soyfood, feed, and nutriceuticals, and therefore enhance the overall soybean production.

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Funding

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

Arkansas blackberries impact US fresh-market production

Issue

Expansion of options of healthy fruits and vegetables available to American consumers continues to be an emphasis of research and development in new varieties. Blackberries are one of the newer fruits found routinely now on retail market shelves. The supply of blackberries has increased to the point that this fruit can be found year-around in many markets. The primary reason that blackberries are a more common item of retail commerce is the development of improved varieties that can be shipped to distant markets. Additional breeding and genetic improvements are increasing grower options for varieties and are key for this industry to continue to expand.

Action

The University of Arkansas fruit breeding program has been working with blackberries since 1964. Repeated cycles of crossing and selection have been carried out to improve many traits including thornlessness, erect canes, productive plants, along with improved fruit characters such as larger

size, increased sweetness, and firm berries that can be shipped. Emphasis on postharvest evaluations has resulted in substantial progress in identifying genotypes with shelf life adequate for distant-market shipping. A series of thornless blackberry varieties has been released including Navaho, Apache, Arapaho, Ouachita, and the newly released Natchez.

Impact

The Ouachita blackberry has been the most widely planted of the Arkansas varieties in the last two years with over 600,000 plants established for commercial production. It has shown coast-to-coast adaptation. Including the other releases, between 1,000,000 and 1,500,000 plants of all Arkansas varieties have been planted in the last two years. The new Natchez had approximately 100,000 plants purchased by commercial growers in its first year of marketing in 2008. Substantial plantings have been established in Arkansas, Georgia, North Carolina and California. Characteristics such as high yields, excellent postharvest performance, sweet berries, and broad adaptation all have contributed to this success. These variety options developed by the University of Arkansas are making blackberries a high-value, profitable crop for specialty crop growers and providing an expanded market for this healthy, natural fruit.

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Funding
Division of Agriculture, University of Arkansas System; Fruit variety royalties

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.

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. The marker work was published in 2008 and has been picked up and utilized by a number of international vegetable seed companies. Dr. Correll also has been invited to participate on the International Working Group Peronospora and is the only U.S. member of this working group.

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Funding
Division of Agriculture, University of Arkansas System

The use of molecular and genetic tools to identify anthracnose pathogens of fruits and vegetables worldwide

Issue

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

Action

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

Impact

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

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Funding
Division of Agriculture, University of Arkansas System

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 characterizing them for their DNA fingerprints and their ability to cause disease on a range of rice cultivars. In addition, efforts have focused on examining isolates that overcome a commonly used resistance gene Pi-ta.

Impact

We have characterized a large collection of rice blast pathogen isolates from throughout Arkansas and have determined that all isolates belong to one of four distinct fingerprint groups. However, one 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.

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Funding
Division of Agriculture, University of Arkansas System

Impact statement on draining rice fields based on rice growth stages

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 drought. Ways to reduce these costs are greatly needed. One way to reduce these costs is to drain rice fields for harvest at a time that will allow water savings and a low likelihood of reducing rice yield or quality.

Action

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

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

Impact

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

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Funding
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Yield dynamics of primocane fruiting blackberries under hightunnel and ambient conditions

Issue

The release of primocane fruiting blackberries by the University of Arkansas Fruit Breeding Program has the potential to revolutionize blackberry production in Arkansas and throughout the United States by shifting the fresh market blackberry production season into late-summer and fall months. This shift offers the potential of higher prices for fresh blackberries. However, climatic conditions in Arkansas during bloom negatively impact fruit quality and yield of these cultivars. Bloom delay techniques until more favorable climatic conditions occur have the potential to produce an economically profitable crop for Arkansas farmers.

Action

Several studies were conducted to determine the effects of various pruning regimes and hightunnels on harvest season extension, yield, and quality of yield of primocane-fruiting blackberries. One experiment included three regimes of one, two, or three successive mowings of primocanes (APF-45 and APF-52). In a second experiment, primocanes (cultivars Prime-Jim and Prime-Jan, and selection APF-46) from which the floricanes had been removed during dormancy

were mown or hedged in June. In a third experiment, floricane fruits were harvested, and primocanes were subjected to hedging or mowing treatments in July. All experiments were conducted under hightunnels and in ambient conditions.

Changing the harvest season with primocane harvests and with the temperature adjustments of hightunnels could have implications for pest management. Sampling was made for three pests: blackberry gall midge (*Contarinia agrimoniae*), strawberry bud clipper (*Anthonomus signatus*), and a broad mite (*Polyphagotarsonemus latus*).

Impact

Results indicate that mowing delays harvest more than hedging, but later and successive mowing decreases yields. Hightunnels had potential to extend the harvest season, though they did not protect crops in some freezes. Mowing treatments delayed harvest, but successive mowing and mowing in June and July reduced yields. Hightunnels did not extend the fall harvest season in 2008. Hightunnels increased average berry weight, total yield, and marketable yield. The broad mite, *P. latus*, was found to damage blackberry leaf and flower bud development. It was also found to overwinter in Fayetteville, Ark. This pest had not been reported previously to affect blackberries or to overwinter in Arkansas.

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Funding
AES- Research Incentive Grant; Division of Agriculture, University of Arkansas System; Southern Region Small Fruit Consortium

Study of grape phylloxera biology and control

Issue

Growers in the Ozark region are transitioning from juice and table grape cultivars to wine grape cultivars that are not rooted on grape phylloxera-resistant rootstocks. These hybrid cultivars have various amounts of *Vitis vinifera* parentage that makes vines susceptible to both foliar and root forms of grape phylloxera. We need to develop a management program that improves the decision-making process for timing insecticide applications against grape phylloxera.

Action

From 21 March, degree-days (DD, base 43.5°F) were accumulated, and weekly counts were made of grape phylloxera crawlers in foliar galls and/or on tape traps on grape canes. The number of cumulative DD was noted for both the start and end of the second generation crawler emergence. On 30 May, effectiveness of application of insecticides was evaluated for preventing leaf galling by grape phylloxera.

Impact

An online picture sheet is available to help growers identify grape phylloxera crawlers:
http://comp.uark.edu/~dtjohnso/GP leaf and root pic sheet Oct 06.pdf

Over 100 grape growers who attended summer tailgate meetings in a vineyard in Arkansas and four meetings in Missouri used this picture sheet and learned how to monitor for presence of second-generation grape phylloxera crawlers. This generation of crawlers emerges from 482 to 900 DD (base 43.5°F) accumulated since 21 March. It is recommended that a grower can prevent foliar galling by applying a soil drench of Admire one month prior to the crawler period or to wait to apply a foliar spray of Assail, Danitol, or Endosulfan when they detect second generation crawlers in May.

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Funding
Missouri Wine and Grape Board; Viticulture Consortium-East Grants Program; Division of Agriculture, University of Arkansas System; Bayer CropScience; United Phosphorus Inc.

Comprehensive disease screening of soybean varieties in Arkansas

Issue

The Arkansas Official Variety Testing program (OVT) for soybean cultivars is conducted each year to evaluate the performance of new varieties in different parts of Arkansas. While this program has been helpful in providing timely yield performance data to Arkansas growers, this program is designed to compare yield performance in the absence of pressure from our common diseases and nematodes. Unfortunately, because numerous diseases occur each year in the state, and at least three economic nematode species are widespread in Arkansas soils, the OVT alone does not provide information on varietal performance under disease pressure.

Action

We have developed an annual screening program to evaluate all cultivars in the OVT each year for resistance or susceptibility to an array of our most common diseases and nematode pests. This program utilizes artificially inoculated field plots, naturally infested field plots, and various greenhouse tests as appropriate to evaluate the potential risks from various fungal and nematode pathogens of soybean. These replicated trials represent the most comprehensive effort to assess the "disease packages" of new soybean cultivars as they come on the market in the southern U.S. All

information is made available to growers, advisors, extension personnel, and the soybean industry through websites for immediate access and is the backbone of the CES Annual Soybean Update publication and the SOYVA computer assisted cultivar selection program.

Impact

Arkansas produces around 120 million bushels of soybeans annually. Yield losses in the state in any given year have been estimated by the Southern Soybean Disease Workers group at around 15% or about 19 million bushels. Proper cultivar selection could conservatively eliminate at least half of these losses, with a resulting increase of over 9.6 million bushels of soybeans for sale by our soybean producers.

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Funding

Arkansas Soybean Promotion Board; Division of Agriculture, University of Arkansas System

Observations of pecan insects in Arkansas

Issue

Pecans and pecan insects have been given little attention from extension and research entomologists in Arkansas over the past few decades. About five years ago, two growers in southwest Arkansas requested help with managing pecan nut casebearer. Pheromone traps were established in their orchards the following year and annual observations have been made on timing of casebearer infestations and of the range of other insect pests attacking pecan in southwest Arkansas.

Action

Observations of the temporal and spatial patterns of pecan nut casebearer, pecan weevil, hickory shuckworm and several stink bug species have been defined and related to available information from Oklahoma, Texas, and Louisiana. In 2008, we expanded some our late-season observations to an orchard in the Arkansas River bottoms east of Little Rock. Timing of pecan nut casebearer and pecan weevil infestations appears to be predictable based on temperature, rainfall and local environment. Stink bug populations are sporadic but tend to move to pecans primarily from maturing soybean grown in adjacent fields. Additional observations are needed to confirm and refine some of these observations, especially the landscape dispersal patterns for stink bugs and frequency and seasonal occurrence of major pecan insect pests in central and eastern Arkansas.

Impact

The initial five years of observations have provided sufficient knowledge and interest in pecan insects that Arkansas has become an official member of S-1017, a regional project devoted to the study of pecan insects. As a cooperating state, Arkansas is now involved in a belt-wide effort to better time and manage pecan nut casebearer. Additionally, the Arkansas Cooperative Extension Service is initiating an effort to better understand and manage pecan insects. Successful maturity of this effort will be a major boost for Arkansas pecan growers. Future research will depend upon the direction of the extension education effort and future funding opportunities.

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Funding

Division of Agriculture, University of Arkansas System

Managing stripe rust and head blight diseases of wheat

Issue

Stripe rust and head blight are two diseases that threaten wheat production and utilization nationally and worldwide. Recent changes in the population of the stripe rust fungus expanded the geographic range where stripe rust occurs and led to more severe disease and greater yield and quality losses. Although head blight reduces yield, the major concern related to this disease is the level of mycotoxins in harvested grain. Deoxynivalenol is the toxin most commonly associated with affected grain, but isolates of the pathogen that produce nivalenol rather than deoxynivalenol have been found in Arkansas, and nivalenol is more toxic 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 Division of Agiculture's Wheat Pathology Program contributes to the national effort to manage both of these diseases by developing germplasm lines with resistance, evaluating breeding lines and cultivars for resistance, characterizing resistances that appear to be most useful, investigating phenotypic and molecular variation of the pathogen populations, and developing chemical control strategies. The Program has also established working relationships with European scientists who have similar interests.

Impact

Growers are able to select cultivars with resistance to these diseases and to use effective fungicides when these diseases threaten their crops. Investigations of the phenotypic and molecular variation of the stripe rust fungus have led to a better understanding of the recent stripe rust epidemics. Graduates students have been educated to conduct research on these diseases.

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Funding:
Arkansas Wheat Promotion Board; U.S. Wheat and Barley Scab Initiative; U.S. Stripe Rust Initiative; Division of Agriculture, University of Arkansas System

Rice varieties in Arkansas

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. Nineteen 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

Fifty-one percent of the rice grown in Arkansas in 2008 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 lb/acre compared to 6850 lb/acre in 2008, which is the highest state average yield in Arkansas history. Assigning a conservative value of 60 percent of this 2740 lb/acre yield increase to new varieties, the average monetary gain in 2008, at a rough rice price of $14.00/cwt, would be $230/acre or $321 million for the 1.394 million acres grown in Arkansas, of which $167 million is due to the Arkansas varieties.

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Funding
Arkansas Rice Research and Promotion Board; Division of Agriculture, University of Arkansas System

A new collard variety

Issue

Collard is a popular greens crop widely grown by home gardeners and it is also important as both a fresh market and a processing vegetable in the southern United States. A regional processor based in Arkansas wanted an open-pollinated collard variety that was more upright in plant habit, that had fewer objectionable stems, and that had better color than varieties that were being grown at that time.

Action

About 20 years ago, the Division of Agriculture's vegetable breeding program began a collard breeding program to address the needs of the processor. The starting point was a variety called 'Georgia Upright.' This variety had some excellent plant types but it was highly variable and was severely infected with black rot, *Xanthomonas campestris*, which is a very serious seed borne disease that can cause disastrous results for growers. The first priority was to get rid of the seed borne disease. By using a combination of hot water seed treatment, as well as Clorox and antibiotic seed treatments, a population of black rot-free plants was developed that was used to start the breeding program. Plants were selected with upright growth habit and dark green color. Several breeding lines were developed and a line was actually increased for release a few years ago, but it proved to be a poor seed producer so it was not released.

Impact

In recent years, other breeding lines have been developed that have excellent upright plant types, good color and produce adequate seed. The breeding line 01-9 was released as the variety 'Ozark' in 2008. It is more upright and has darker green color than the industry standard 'Champion.'

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Funding
Allen Canning Company; Division of Agriculture, University of Arkansas System

Economics of pre-harvest mechanization

Issue

Many small- to medium-sized farms are finding it difficult to maintain economic viability through a traditional focus on livestock, poultry, or agronomic crops. Increasingly, these farms are exploring alternative or non-traditional crops as a way of increasing profitability of their farming operations. Wine and juice grapes are one alternative that holds considerable promise. On a per-acre basis, vineyards can command returns that greatly exceed returns from conventional crops. Furthermore, grapes provide tremendous potential for value-added marketing opportunities at the farm level, thereby increasing the farmer's share of the consumer's dollar. Forty years of research culminated in the development of the Morris-Oldridge System for total vineyard mechanization. A comprehensive examination of the economic consequences of this system under actual commercial conditions is needed to demonstrate the value of the research and the potential of mechanization to increase the long-term profitability of grape production.

Action

A comprehensive set of materials is being developed to address challenges confronting vineyard operators, processors, and wineries. These emphasize good agricultural and handling practices for grapes, yearly timetables for vineyard operations, and the economics of establishing and operating vineyards. Budgets were prepared to compare production costs under mechanized and traditional hand-farming systems. An additional economic model was developed to assess the value of the ability to more consistently meet yield targets, an important advantage inherent in mechanization. In January and February 2008, findings on vineyard economics or vineyard mechanization practices were presented at two major regional grower meetings. Mechanization significantly reduces costs. Ancillary work is also being done to address retail markets for grapes and grape products and assess the potential of high-value products derived from grapes and grape by-products.

Impact

Scarcity of labor, its increased cost, and increased competition from producing areas overseas threaten the long-term competitiveness of the U.S. grape industry. Mechanization significantly reduces labor costs, with demonstrated savings of $300 to $600 per acre (savings of approximately 45-60%) in production costs. In addition, depending upon the trellising system, the potential value of the grapes, and the magnitude of yield risk, the increased flexibility of mechanization in meeting yield targets provides an increase in value from $100 to over $400 per acre. Mechanization can play a crucial role in meeting the challenges facing the U.S. grape industry. Practical and timely information has been provided for growers considering the transition to mechanized farming systems.

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Funding

Division of Agriculture, University of Arkansas System

Enhancement of family farms through value-added grape products

Issue

Considerable interest in grapes and wine exists on the part of potential growers, entrepreneurs, and consumers. The promise of this industry for agriculture in the South and Midwest is tremendous in terms of a highly valued alternative crop for producers, the ability to add value locally, and the economic opportunities in rural areas that can be provided by farm-based wineries and processing enterprises. Under a project supported by the National Research Initiative of the USDA Cooperative State Research, Education and Extension Service, work has been conducted with the goals of ensuring that information and timely assistance is available to promote the development, and increase the success, of the regional grape and wine industry.

Action

An update of *The Muscadine Experience: Adding Value to Enhance Profit* was prepared and printed. New material added to this booklet includes data comparing the cost of establishing a muscadine vineyard with the costs for other types of grapes and operating costs for vineyards of different grape species. Some of the data tables were revised to improve clarity and the references were updated. A major effort toward the project goals this year has been the development of the publication, *Considerations for Starting a Winery*. The goal of this publication is to provide information about requirements and procedures for starting a winery. It was not designed as a "how-to" manual but rather serves as a starting point to investigate the many aspects of owning and operating a winery. Although the manuscript frequently refers to procedures for starting a winery in Arkansas, the concepts presented are applicable throughout the United States. A companion publication offering detailed economic information on starting a winery is currently being prepared. An outreach activity associated with this grant was the development of a website designed to promote the wine industry in Arkansas. This site, "Uncorking Arkansas's Wine Country," was designed to encourage people to visit Arkansas's wineries and the areas surrounding them. It has been posted on-line as part of the University of Arkansas Grape and Wine Program website and has been offered for inclusion on the Arkansas State Department of Tourism website. Additional outreach activities this year have focused on the continued development of materials to address challenges confronting new and existing vineyard operators. Materials have emphasized good agricultural and handling practices for grapes, yearly timetables for vineyard operations, and the economics of establishing and operating a vineyard. Additional materials developed to assist in adding value to grape products include information to help entrepreneurs choose a co-packer and a list of regional co-packers. Progress has continued towards completing budget

templates that integrate a variety of economic and viticultural considerations. In particular, insecticide and fungicide spray recommendations provided by Cooperative Extension Services throughout the study region were incorporated into the budget templates to provide a user-friendly means of evaluating the costs of different insect and disease control strategies.

Impact

The numerous contributions to, and provision of, research and Extension information provide invaluable assistance to wineries, grape growers, potential growers, entrepreneurs, and consumers in improving the efficiency and quality of production, the quality of products, the development of new value-added products, the marketing of grape products, and the potential for grape-related agritourism.

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Funding
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Increase efficacy, economic viability, and sustainability of a total vineyard mechanization system

Issue

According to the National Grape and Wine Initiative, the U.S. grape industry has an annual economic impact of $50 billion. Growers of premium wine grape varietals rely heavily on hand labor in vineyards with labor accounting for as much as 75 to 85% of pre-harvest costs. Scarcity and increased cost of labor along with increased competition from producing regions overseas (some with much cheaper labor) have caused growers to examine various forms of mechanization in the vineyard in order to remain competitive in the grape and wine market, Harvest mechanization has been available commercially since the late 1960s. However, traditional vineyard operations along with the large number of grape species, trellising systems, and their combinations have impeded the progress of overall vineyard mechanization.

Action

Since 1966, a great deal of research at the University of Arkansas has been dedicated to defining factors affecting vineyard uniformity and designing total grape vineyard mechanization systems that optimize yield without detrimental effects on grape juice or wine quality. The Morris-Oldridge (M-O) Total Vineyard Mechanization System was patented in 2002. Large-scale research studies to verify the commercial effectiveness of this M-O System have been underway in California since 2002. The impact of total vineyard mechanization on the raw product quality and on final juice and wine quality has been continually assessed. Maintenance of yield and fruit quality has been demonstrated while reducing costs by as much as 70%. Machine farming is more consistent than hand farming. With the goals of balancing the crop and optimizing yield and fruit quality in a specific vineyard, the "balanced cropping" achieved with mechanization has actually provided an average increase in yield of 26%, and allows maintenance of this consistently higher yield. This ability to produce a consistent annual yield may have equal or greater economic impact than the labor-saving aspect of mechanization. Additional years of research on these plots will allow verification of these trends as well as provide an opportunity to study the long-term effects of mechanization on vine vigor and fruit quality. Work continues on efforts to apply the System to additional trellis systems and cultivars. The quality of wines made from grapes produced by machine vs hand methods continues to be investigated. Analyses are run to determine chemical and sensory quality. Chemical analyses include determination of alcohol, degrees Brix, carbon dioxide, volatile acidity, tannins, phenolics, and anthocyanins using standard procedures. Sensory analyses are also done on the wines. No diminution of quality has been detected in wine from machine-farmed grapes, with those wines in fact being more favorably evaluated in some cases. In addition to this vineyard mechanization work, data from our other research continue to be published in the scientific literature.

Impact

The M-O System is being marketed commercially by Oxbo International as part of their complete vineyard mechanization Korvan™ Vineyard brand. The cost savings that can be realized from mechanizing pre-harvest operations are economically important. Our published work indicates that these cost savings can be estimated at $273 per acre on a Vertical Shoot Positioned trellising system (VSP), $529 per acre on a Two-foot Lyre, and $612 per acre on a Quadrilateral. Implementation of the M-O System has reduced costs by as much as 70%. Perhaps most importantly, these savings have been obtained while maintaining yield and fruit quality. In addition, the use of mechanized production systems has the potential to stabilize grape yield and supply for wineries through the concept of "balanced cropping." This aspect of the M-O System—the ability to produce consistent annual yields—may have equal or greater economic impact than the labor-saving aspect. The vineyard data have shown that commercial mechanization systems can be used by growers to successfully achieve the yield, quality, and canopy management goals that are expected of them by wineries. Widespread implementation of total vineyard mechanization will save grape growers tens of millions of dollars annually.

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Funding
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Improving nitrogen fertility management for corn production in Arkansas

Issue

Nitrogen fertilizer is one of the largest variable inputs in corn production. Record-high N fertilizer prices have significantly reduced the growers' profit margin. Increasing N use efficiency through fertility management practices that maintain high crop yields will increase the grower's profit margin and reduce the risk of potential water quality problems.

Action

Field experiments were conducted at five locations to evaluate: 1) the effect of N fertilizer on corn and 2) the potential for using chlorophyll meter to determine the need for in-season N fertilization of corn.

Impact

Nitrogen application significantly increased corn grain yield and leaf chlorophyll measurement at all five sites. Corn grain yield for the 0 N plots ranged from 32 to 127 bu/acre and 174-271 bu/acre for plots treated with 300 lb N/acre. In general yield and chlorophyll meter readings increased as the N application rate increased and maximum yield was produced by application of 240 to 300 lb N/acre. Relative chlorophyll meter reading was well correlated with relative corn yield and or relative leaf nitrogen. These results indicate that a handheld chlorophyll meter can potentially be used to predict the need for in-season supplemental application of N and prevention of excessive N fertilizer application.

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Funding

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

Improving cotton phosphorus (P) and potassium (K) fertility recommendations in Arkansas

Issue

Arkansas cotton producers are facing low commodity prices and record-high P and K fertilizer expenses. Information on response of modern cotton cultivars to P and K fertilization is needed to evaluate and if needed, revise the existing cotton P and K fertilization practices. Improved P and K fertilizer recommendations will help the growers to increase their profit margin.

Action

A field experiment was conducted on a Commerce silt loam soil to evaluate cotton and soil response to application of 0-120 lb P_2O_5/acre (applied at 30 lb/acre increments). Another field experiment was conducted on a Convent silt loam soil to evaluate cotton and soil response to application of 0-150 lb K_2O/acre (applied at 30 lb/acre increments). These soils are representative of agricultural soils used for cotton production in Arkansas.

Impact

Pre-plant Commerce soil was rated 'Low' in P. Seedcotton yield in P study ranged from 1889 to 3275 lb/acre and, compared to the no P control, seedcotton yield was significantly increased by all rates of P fertilization. Application of 90-120 lb P_2O_5/acre produced maximal seedcotton yields, which were about 70% higher than cotton receiving no P. Phosphorus-fertilizer rate also significantly increased post-harvest soil-test P. Soil-test P in soil receiving P fertilizer increased as P rate increased and ranged from 22-46 ppm. Application of 120 lb P_2O_5/acre was needed to increased soil-test P rating from 'Low' to 'Optimum'.

At K study site, seedcotton yield ranged from 2973 to 4317 lb/acre and was significantly increased by K fertilizer application rate. Potassium application rates >30 lb K_2O/acre significantly increased seedcotton yields compared to the no K control. Post-harvest, soil-test K was also significantly influenced by annual K-fertilizer rate with mean values ranging from 82 to 125 ppm.

These results indicate that on soils rated 'Low' in P, or rated 'Low' to 'Medium' in K, application of P or K fertilizer is needed to produce maximum seedcotton yield and buildup soil P and K. Growers will benefit from soil test-based recommendation by applying fertilizers when there is a reasonable assurance of increased cotton yield and revenue.

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Funding

Division of Agriculture, University of Arkansas System

Evaluation of Agrotain- and Nutrisphere-coated urea and Super U as concerns ammonia volatilization and nitrification

Issue

One of the difficulties in the management of the nitrogen (N) fertilizer applied preflood to delayed-flood rice is the timeliness of the flood following urea-N fertilizer application. Previous research in Arkansas has shown that 20 to 30% of the urea-N applied preflood can be lost via ammonia volatilization if the flood is delayed for 5 to 10 days past the N fertilizer application. Most commercial rice fields require 5 to 10 days to establish a flood across the entire field. Urease inhibitors have been promoted as a means to significantly slow ammonia volatilization losses from urea and allow time for the floodwater to incorporate the urea in the soil. Two products promoted as containing urease inhibitors

are Agrotain and Nutrisphere. The objectives of the studies reported here were to evaluate urea, Agrotain-coated urea, and Nutrisphere-coated urea as to their ammonia volatility when applied to soil and their influence on rice yield when applied at various times prior to flood establishment.

Action

Laboratory and field studies were conducted comparing the ammonia volatility and influence on rice grain yield of urea, Agrotain-coated urea, and Nutrisphere-coated urea applied at different times prior to flooding. When the N fertilizers were applied 5 and 10 days prior to flooding, rice yields were significantly greater for Agrotain-treated urea compared to untreated urea. Nutrisphere-treated urea and untreated urea applied 5 and 10 days prior to flooding produced similar rice grain yields, indicating the Nutrisphere was apparently not inhibiting or minimizing ammonia volatilization of urea. Consequently, laboratory/incubation studies were conducted to see if Nutrisphere had any influence on the ammonia volatility of urea. The laboratory study showed that untreated urea and Nutrisphere-treated urea volatilized ammonia similarly and in much greater amounts compared to Agrotain-treated urea. Nutrisphere has also been purported to have nitrification inhibition qualities so we decided to also test that claim. In the nitrification study, untreated urea and Nutrisphere-treated urea were compared to Super U, which is urea in combination with the documented nitrification inhibitor dicyandiamide. The laboratory/incubation study determined untreated urea and Nutrisphere-treated urea nitrified similarly and in significantly greater amounts compared to Super U.

Impact

Agrotain's ability to inhibit ammonia volatilization of urea and Nutrisphere's inability to inhibit ammonia volatilization of urea indicated Agrotain is an effective urease inhibitor and Nutrisphere is not. Also, Super U proved to contain an effective nitrification inhibitor (dicyandiamide) and Nutrisphere proved to be an ineffective nitrification inhibitor. Thus, Agrotain should be used when a urease inhibitor is needed to minimize the ammonia volatilization of urea and dicyandiamide should be used when a nitrification inhibitor is required. Nutrisphere is not an effective urease inhibitor to minimize ammonia volatilization of urea nor is it an effective nitrification inhibitor. Consequently, Nutrisphere should not be recommended or used.

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Funding
Division of Agriculture, University of Arkansas System

Weed seed contamination of cotton gin trash

Issue

Disposal of cotton gin trash is potentially leading to long-distance dispersal of herbicide-resistant weeds, particularly glyphosate-resistant Palmer amaranth. The objectives of this research were to determine the weed species most frequently found in gin trash and determine what means gin operators are using to dispose of gin trash.

Action

Cotton gins in Arkansas, western Tennessee, and western Mississippi were sampled for weed seed contamination of gin trash in fall 2007. A total of 473 samples were collected, with 453 samples from Arkansas. Additionally, gin operators were asked a series of questions concerning their handling and disposal of gin trash. One- and two-year-old gin trash piles were evaluated for the presence of viable weed seed.

Impact

There were 25 weed species found in the gin trash samples— eleven grass and fourteen broadleaf weeds. Grass and broadleaf weeds were present in 41.4% and 8.5% of the samples, respectively. The most frequently found species were large crabgrass (19.0%), barnyardgrass (14.0%), goosegrass (12.9%), red sprangletop (8.2%) and Palmer amaranth (4.2%). Viable seeds of barnyardgrass, large crabgrass, Palmer amaranth, and prickly sida were present in the surface layer (0- to 12-inch depth) of gin trash piles after 1 yr of composting. Viable Palmer amaranth seeds were present in the surface layer of gin trash piles after 2 yr of composting, but no germinable seeds were found deeper than 25 cm following 1 yr of composting. Gin trash disposal involved application of the material to crop fields during the fall or winter months; composting followed by application of the compost as mulch or a soil amendment to gardens, flower beds, or crop fields; use as cattle feed; and coverage for landfills to reduce erosion and encourage growth of vegetation. Because of the demonstrated potential for weed seed dispersal via gin trash, including composted material, development of technologies to ensure disposal of a gin-trash product free of viable weed seed is needed.

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Evolution and management of glyphosate-resistant Palmer amaranth in cotton: The role of residual herbicides in mitigating risks of glyphosate resistance

Issue

Glyphosate-resistant Palmer amaranth has rapidly become the most troublesome weed of Arkansas cotton. Simulation models may allow strategies to be developed to reduce the risk of resistance developing on individual farms.

Action

A simulation model has been developed that examines the evolution and management of glyphosate resistance in populations of Palmer amaranth in southern US cotton production systems. Risks of glyphosate-resistance evolution in Palmer amaranth were compared for eight different weed management scenarios in continuous glyphosate-resistant cotton monoculture.

Impact

In the 'worst case scenario' where there were five annual applications of glyphosate and no other herbicides applied, glyphosate resistance was predicted in 59% of populations after five years. In all other scenarios, glyphosate was applied together with various combinations of pre-plant, preemergence, and postemergence residual herbicides. In all cases of addition of alternative modes of action, residual herbicides reduced predicted rates of resistance. A single application of fomesafen (Reflex) pre-crop planting was effective in slowing the rate of glyphosate-resistance evolution by two years and reducing the overall risk of resistance to 30% over the 20-yr simulation. The most effective strategy combined four glyphosate applications with a pre-planting fomesafen application, a postemergence tank mix of glyphosate and S-metolachlor (Dual II Magnum) and a lay-by tank mix of glyphosate and flumioxazin (Valor). Under this scenario, resistance was predicted in just 10% of populations. This analysis has clearly demonstrated the utility of simulation models for designing, assessing and comparing glyphosate-resistance management strategies in glyphosate-resistant cotton. Furthermore, these modeling efforts will help to direct future field trials and recommendations for producers battling to control Palmer amaranth.

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Confirmation, spread, and management of glyphosate-resistant Johnsongrass

Issue

Johnsongrass was among the most troublesome grass weeds of soybean prior to the adoption of glyphosate-resistant soybean by Arkansas producers. In recent years, Johnsongrass has not been a problem due to the effectiveness of glyphosate herbicide on this weed. Glyphosate failed to
provide adequate control of a Johnsongrass population in a soybean field near West Memphis, Ark., in Crittenden County in 2007.

Action

Johnsongrass rhizomes were collected in fall 2007 and taken to Lonoke, Ark., for further evaluation. Rhizomatous Johnsongrass was treated with glyphosate at 0.75 lb ae/A (the normal use rate), which again failed to provide sufficient control. Rhizomes from these plants were brought to Fayetteville and planted in potting mix in containers in the greenhouse. Six plants propagated from these rhizomes were transplanted to the field in early spring and treated with three applications of glyphosate at 0.75 lb/A. The plants failed to respond to glyphosate. In fall 2008, seeds were collected from these plants and sown in the greenhouse. Seedling Johnsongrass (plants grown from seed) of the suspected resistant biotype and seedlings of a susceptible biotype were treated at the three-leaf stage with 9 rates of glyphosate, ranging from 0.023 to 6 lb/A. The lowest rate corresponded to 1/32x the normal use rate and the highest rate was 8x the normal use rate. Plant death (live or dead) was recorded at 21 days after treatment. The lethal dose needed to kill 50% of plants of each biotype (LD50) was determined using Probit analysis. Further sampling in this field and adjacent fields took place in fall 2008. Forty-two georeferenced samples were collected and evaluated for resistance to determine the extent of the infestation. Additionally, 12 herbicides were evaluated for control of the resistant biotype.

Impact

The resistant biotype had an LD50 of 1.29 lb/A glyphosate, which was 7.2-fold greater than the susceptible biotype, which had an LD50 of 0.18 lb/A glyphosate. To kill 90% of the resistant plants, 2.44 lb/A glyphosate was needed compared to 0.32 lb/A for the susceptible biotype, a 7.6-fold difference. This is the first known case of glyphosate-resistant Johnsongrass in Arkansas. Based on sampling at the site and in adjacent fields, the resistant biotype appears to currently infest approximately 50 acres, with no known movement out of the field where resistance was confirmed (based on susceptible populations in all adjacent fields). The glyphosate-resistant biotype was effectively controlled at the

seedling stage with the ACCase herbicides clethodim (Select) and fluazifop (Assure II), but all others only provided partial control. Efforts must be taken to prevent the spread of the resistant biotype from this field and effective control options are available.

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The use of the plant growth regulator Chaperone for increasing protein content, endotoxin, insect mortality and yield in transgenic cotton

Issue

Application of plant growth regulators (PGRs) to cotton (*Gossypium hirsutum* L.) to improve cotton growth and increase yield is a widely accepted practice in cotton production. Numerous PGRs have been produced and sold to farmers with claims of improving growth and increasing yield. However, most of these PGRs have proven either not to work or to be inconsistent. The most successful and most widely used PGR in cotton is mepiquat chloride for controlling plant growth. Recently, the PGR ChaperoneTM was introduced into the cotton market with claims of enhanced plant protein levels causing an increase in yield. The product was labeled and sold as a plant protein enhancer; however, the evidence was lacking. The objective of this study was to test the PGR Chaperone for its effect on plant nitrogen and protein levels and yield. In addition, since the endotoxin in Bt cotton is a protein, it was speculated that if Chaperone increased protein levels, it would also increase the endotoxin levels, and therefore bollworm mortality from the Bt endotoxin would increase.

Action

Field and growth chamber studies were conducted between 2002 and 2008 to quantify the effect of foliar applications of Chaperone on plant nitrogen content, protein levels in leaves and squares and effect on yield. The effect on leaf and square endotoxin levels and insect mortality were recorded. Preliminary studies determined that the optimum rate and timing of Chaperone was 350 ml/ha applied once at the start of flowering. In field studies, one week after Chaperone at 5 oz/acre was applied at first flower, it increased petiole nitrate levels by 12%, proteins in the leaves by 4% and in the squares by 13%, and yield by 8% compared to the untreated control. In addition, there was improved expression of the Bt endotoxin protein in the squares by 6%. The increased endotoxin protein resulted in 10% higher mortality of bollworms feeding on treated plants compared to untreated leaves 10 days after application. These results were confirmed in two growth-room studies.

Impact

The results from the growth chamber and field studies showed that foliar applications of Chaperone may be a viable means for increasing lint yields in cotton through the enhancement of plant protein levels. Furthermore, the enhanced protein status contributes to improved late-season endotoxin levels, particularly in the squares, that contribute to increase mortality of neonate bollworms feeding on the treated plants.

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Funding

LTA Resource Management and Cotton Incorporated, Cary, N.C., Project #04-442AR); Division of Agriculture, University of Arkansas System

Radiation-use efficiency and yield productivity in cotton

Issue

Growth and yield of the cotton crop varies among geographical locations, and this has been assumed to be due to differences in environmental parameters, such as temperature, relative humidity, solar radiation and vapor-pressure deficit. Previous research has shown that increasing vapor pressure deficit has a negative effect on radiation-use efficiency of many crops, but this has not been shown for cotton. California has similar production practices but significantly higher yields that those in the Midsouth. It has been speculated that this could be due to longer season and better use of incoming solar radiation. In this study, the radiation-use efficiency of cotton (*Gossypium hirsutum* L.) grown in two contrasting production environments, Arkansas and California, was evaluated for two years.

Action

Field studies were planted at Marianna, Ark., and Fresno, Calif., using large replicated field plots in 2006 and 2007. Temperature, relative humidity, vapor-pressure deficit, and photosynthetically active radiation (PAR) were recorded at both locations.

Although the crop in California accumulated more dry matter during the period of the season, the radiation-use efficiency was found to be lower compared to Arkansas. Radiation-use efficiency for the Arkansas and California locations was estimated at 2.060 and 1.518 $g \cdot MJ^{-1}$ of intercepted PAR, respectively.

Impact

The higher productivity observed in California can be attributed to larger amounts of incident and intercepted radiation in this location and higher vapor pressure deficits in the drier environment. Radiation use efficiency of cotton was

estimated to decrease with increasing vapor pressure deficit by a slope of -0.47 $g \cdot MJ^{-1} \cdot kPa^{-1}$. These findings on the importance of the duration of intercepted radiation and the vapor pressure deficit in crop productivity explains yield differences in the two environments and the information will be of use in crop growth models for predicting productivity and yield in different locations.

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Funding

LTA Resource Management; Division of Agriculture, University of Arkansas System

Landowner's guide to determining weight of standing hardwood trees

Issue

The market exchange medium for standing trees has changed from selling by the volume (such as board foot) to selling by the ton. Landowners need to know how many tons of merchantable hardwood logs can be harvested from their stands so they can estimate the value of their stands.

Action

Researchers went to the forests and measured 272 trees. After the loggers cut the trees, they weighed the marketable logs. Using the individual tree data, two equations were developed. The first will predict the weight of the merchantable portion if the landowner only measures to diameter at breast height (DBH – 4 ½ feet above ground) and the second equation uses DBH and total tree height to predict the same. Naturally, the second equation is 5% more accurate. The researchers also developed ratios of tree species weight per cubic foot to the average weight per cubic foot for 272 trees. Tables were developed to assist in adjusting the equation-predicted weight to a more accurate species weight. The researchers then published the information in an Arkansas Extension Fact Sheet: Patterson, D.W. and P.F. Doruska. 2008. Landowner's guide to determining weight of standing hardwood trees. University of Arkansas Cooperative Extension Service. Little Rock, Ark. Fact Sheet FSA5021. 4p.

Impact

With the aforementioned information, the landowners of Arkansas can measure their trees and accurately estimate the tons of merchantable material available in their hardwood stands. By researching the current market value per ton, the landowners can arrive at a fair monetary value for their timber. When it comes time to sell, they will be able to know when buyers are offering them a fair price.

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Switchgrass issues for Arkansas agriculture: A 2007 baseline

Issue

The need for biomass feedstock for renewable energy from agriculture has intensified with the recent passage of the 2007 Energy bill. Therefore, many agricultural producers are contemplating what crops to grow in the foreseeable future. On one hand are traditional food crops like soybean, corn, wheat and rice that have recently enjoyed a spike in prices primarily due to the seemingly ever-growing demands of the corn to ethanol industry. On the other hand are less-known perennial energy crops like switchgrass. While much information on various aspects of switchgrass production exists, some discussion on the adaptation of existing production and processing information to Arkansas conditions as a potential alternative to crop production was needed.

Action

The objectives of this study were to: 1) document existing cost of production information for growing switchgrass in Arkansas along with some assumptions about likely and easily adoptable production methods; 2) utilize the cost of production information to determine breakeven prices for producers and/or biorefineries under varying assumptions related to stand life; 3) conduct some sensitivity analyses regarding expected harvesting and transportation costs to biomass production facilities; and 4) discuss impediments and advantages for the adoption of switchgrass as an alternative crop in Arkansas.

Impact

The analysis revealed that prorated cost of production over a 12-year useful life led to a breakeven price of nearly $25/dry ton of switchgrass stored at the edge of the field. Changing the useful life of the stand to 6 years, the breakeven price increased to nearly $33/dry ton. Storage losses and transport charges added nearly $12/dry ton to the above, and producer payments for considering the crop added nearly $18/dry ton. This information proved useful for highlighting the need for exploring additional storage, harvest and transport techniques as well as providing a baseline for delivered feedstock costs to biorefineries. Expected future yield improvements and storage, harvest, and transport efficiencies would lower the above cost estimates, but competition for land resources may also raise producer payments required.

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Differential wilting of soybean

Issue

Different soybean genotypes have different degrees of wilting when exposed to drought. The repeatability of these differences and the reasons for some genotypes wilting soon after a drought begins and some genotypes wilting later during a drought are not known.

Action

We planted 19 soybean genotypes in wide (32 in) and narrow (7.5 in) rows for two years to determine if the ability to extract water from the center of rows was different among genotypes. We also evaluated soil-water extraction from fast- and slow-wilting genotypes at soil depths of 6, 12, and 20 inches. Our results indicate that wilting ratings are repeatable across years and retain similar genotypic rankings. Further, slow wilting appears to be due to less water being extracted from soil throughout the season, which allows more water to be available in the soil when drought conditions occur.

Impact

Because wilting ratings are repeatable, breeding methods can be employed to understand the genetics of the trait and to incorporate this into commercial varieties if desired. Understanding the mechanism responsible for slow wilting allows predictions as to what conditions this trait would be of value in ameliorating yield loss due to drought.

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United Soybean Board; Division of Agriculture, University of Arkansas System

Regulation of N_2 fixation under drought

Issue

Previous research indicates that the products of N_2 fixation in soybean (ureides) accumulate during drought and that ureides may signal the plant to decrease N_2 fixation

Action

We measured the transcripts (mRNA) of the enzyme responsible for degrading the ureides under well-watered and drought conditions for both drought-tolerant and drought-sensitive genotypes. Results indicated that there was no difference in transcript level under well-watered and drought conditions or between drought-tolerant and drought-sensitive genotypes despite large differences in leaf ureide concentrations.

Impact

Because gene expression for the enzyme responsible for ureide catabolism did not change in response to drought despite increases in ureide concentration, regulation of enzyme activity is likely at the translational or post translational stages. Understanding the mechanism by which ureides affect N_2 fixation and how ureide metabolism is affected by drought may provide new and directed strategies for increasing soybean drought tolerance.

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Funding

United Soybean Board; Research Incentive Grant, Division of Agriculture, University of Arkansas System

Starting a wholesale nursery: Diversification through alternative enterprises

Issue

Producers of traditional row crops (e.g. rice, cotton, soybeans) in the Delta region of Arkansas are looking for agricultural alternatives to stabilize and potentially increase farm revenues. Ornamental horticulture is one of the fastest growing segments of agriculture in the United States. Nursery production in Arkansas, ranked at 32nd in the United States, is considered the sector with greatest growth potential. Access to major transportation lanes, reasonably priced agricultural land, labor, water, and other resources makes Arkansas a prime state for large-scale nursery production. According to a Cooperative Extension Service (CES) survey in 2003, 45% of woody plant material in Arkansas is imported from other states. Arkansas nursery products could also be exported to many states.

A majority of county agents are not technically trained in horticulture, and need assistance in handling horticulture issues. Existing ornamental horticulture businesses require training and exposure in new plants and production methods to stay competitive. Tremendous opportunities exist for new ornamental horticulture business in Arkansas but these businesses require training and technical assistance.

Action

Cooperative Extension Service programs are designed to focus efforts on enhancing current ornamental horticulture businesses and to start new businesses. CES programs are focusing their efforts in 4 primary areas:

- technical training and support for new and existing ornamental horticulture businesses and county extension agents.
- printed and Internet-based fact sheets and a quarterly newsletter distributed to existing ornamental horticulture businesses.
- Web-based materials designed to support quick access to timely and intensive graphics-based information.

• A statewide plant evaluation program initiated in 1999 designed to evaluate and help market 'new' plant material for the Arkansas market.

Impact

Cooperative efforts by a team of faculty and staff within the Cooperative Extension Service have helped the third largest rice producer in the Delta region transition from rice to wholesale nursery production. The farm, located in Harrisburg, has planted a total of 120 acres of ornamental trees since the spring of 2002 with an estimated wholesale value of $2.5 million. This same team of University experts is also helping a former row crop farmer in White County transition to ornamental shade tree production. In 2005, field nurseries started production in Clay and Jackson Counties and container nurseries started production in Washington and Independence Counties. An additional nursery started container production in Washington County in 2006.

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Arkansas Green Industry Association; Arkansas Farm Bureau; Arkansas State Plant Board; Division of Agriculture, University of Arkansas System

Host resistance as the cornerstone for managing plant-parasitic nematodes in sustainable agroecosystems

Issue

The reniform nematode is responsible for millions of dollars in crop yields of cotton and soybean in the southern region of the U.S. The contemporary soybean varieties identified as resistant to reniform nematode are very useful as rotations as an alternative to the use of environmentally unfriendly chemical nematicides.

Action

During 2008, 162 soybean varieties from the Arkansas variety testing program and 82 breeding lines and varieties were tested in the greenhouse to determine their suitability as hosts for the reniform nematode (RN), *Rotylenchulus reniformis*. Of the Arkansas test varieties 152 of 162 supported more RN reproduction than Forrest, which was the control variety.

Impact

Extension nematologists in Texas, Louisiana, Alabama, Mississippi, Georgia, Florida, and South Carolina often request our reniform data on soybean cultivars to help in the selection of reniform-resistant crops for rotation in reniform-infested fields. The identification of soybean breeding lines with low reniform nematode RI's is useful in breeding new varieties with good resistance to this nematode. Of 58 soybean plant introductions not previously tested that were found to have resistance to the soybean cyst nematode, six were more resistant than Anand, our best resistant variety. The newly tested soybean plant introductions with low reniform nematode reproductive indices will be especially helpful in breeding for reniform resistance.

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Arkansas Soybean Promotion Board; Division of Agriculture, University of Arkansas System

Phytoparasitic nematodes: Their taxonomy, morphology, distribution, identification and damage thresholds on crops important to Arkansas

Issue

Nematode identification is vital to crop production and protection. The presence of certain species can result in reductions in crop yield or quality. Without correct and timely nematode species identification, ineffective or inappropriate control measures may be implemented. The ability to identify species is very important when shipments are made to other countries where nematode quarantines are in effect.

Action

During 2008 several new nematode species were identified and described. Whereas most came from non-agricultural hosts, their ability to infest and injure economic crops is unknown and open to question. The ability to distinguish between them and closely related species known to be economic pests is very important in the need to control them or even possibly clear them in quarantine situations.

Impact

New species descriptions are important as they can often be confused with other species that have a large economic impact on various forestry, food and fiber crops. Species identification, either morphologically or molecularly, of *Longidoridae* and *Hoplolaimidae* species recently described may be useful in clearing quarantine shipments. Failure to correctly identify nematode species can cause agricultural shipments to be refused in countries with strict quarantine laws against specific nematode species. Failure to make correct identifications can also lead to costly and unneeded control measures.

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Division of Agriculture, University of Arkansas System; various unrestricted gifts

Genetic variability in the cyst and root-knot nematodes

Issue

Soybean cyst nematode (SCN) is the most severe and widespread disease of soybean in Arkansas as well as many other soybean production areas of the US. Rotation and resistant varieties are the most economical and effective control measures. Chemical control is used sparingly because of it high cost and erratic results. Planting a single type of resistance can lead to the formation of resistance breaking SCN races. At least three different soybean resistant reactions to soybean cyst nematode infections exist. In this study the resistances derived from the soybean plant introductions Peking (Manokin), Pi88788 (AG 5501), and PI 437654 are rotated.

Action

Large-plot rotation studies in which three different modes of soybean cyst resistance are rotated are in progress. In this study the resistances derived from the soybean plant introductions Peking (Manokin), PI 88788 (AG 5501), and PI 437654 (Anand) are rotated in all combinations and compared to each other and the susceptible variety Hucheson. The study field originally tested as SCN race 6.

Impact

In 2008, the sixth test year, Anand soybean showed decreases in SCN numbers in all its plots at harvest, whereas Manokin and Hutcheson increased in all their at-harvest plots. AG 5501 gave mixed results. In 2007 and 2008, Anand gave the highest yields, both in the rotations and when grown continuously. Reproductive indices for all years of all rotations were lowest (less than 1) in all cases. The reproductive indices for all years of SCN on continuous grown Manokin and AG 5501 were 2.23 and 2.16 respectively. The second test (Roundup Ready Varieties) at harvest in 2008, the third test year, all rotations and continuously planted resistant varieties yielded greater than the continuously grown susceptible varieties. In this test, Cystex resistance was substituted for Peking resistance. Data from these tests will help determine if these rotations 1) are useful in controlling soybean cyst nematode (SCN), and 2) prevent SCN race changes from occurring. If successful, they could allow soybean to be grown without rotation to less-profitable crops.

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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 have been substantial. Additionally, both consumers and farmers are increasingly interested in 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 sources 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) control (where the ground cover management treatment becomes the source of nutrition), B) 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.

Impact

Both ground cover and nutrient source had profound effects on tree growth during the establishment of the orchard. Trees grown with green compost and wood chips were large and vigorous while those using shredded white paper and mow-and-blow were smaller. In preliminary experiments, shredded paper on well established mature trees appeared to have benefits, but this treatment had severe, negative consequences with very poor growth and allowed winter injury in a sudden late-winter freeze event. Shredded paper and wood chips significantly reduced weeds while weeds grew well in the compost and had some growth effects on the tree. The competition of the managed understory growth in the mow-and-blow treatment significantly affected the tree. It was determined that light cultivation

was needed for all treatment to reduce the impact of weeds. Trees treated with poultry litter had more weeds than those without additional nutrients added. During a winter snow and ice event, significant damage was caused to trees in the mow-and-blow treatments due to meadow mice feeding on the tree trunks and killing trees. Trees with woodchip mulch had the lowest incidence of mouse feeding damage. After two seasons, trees receiving green compost or woodchips ground-cover treatment were 9 to 10 feet tall and had sufficient structure to crop the following year. Likewise, trees with the poultry litter and commercial organic fertilizer were of similar size while those without additional nutrients were smaller. In the first cropping season, trees with shredded paper and mow-and-blow had significantly fewer flowers and were too small to produce a crop. However, trees with green compost and woodchips produced a significant crop. Trees without additional nutrients had fewer flowers and did not produce a crop while those that received either poultry litter or a commercial fertilizer produced a similar crop.

Impact

These data provide the basis for 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 - Southern Sustainable Agriculture Research and Education Program; USDA Integrated Organic Program; Division of Agriculture, University of Arkansas System

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. Together with traditional floricane blackberries and raspberries, high tunnels, therefore, have the possibility of extending a five- to six-week crop by an additional four to six weeks in the spring, and by an additional six to eight weeks in the fall with primocane types.

Action

An interdisciplinary research trial was established to produce floricane 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. Three cultivars of floricane blackberries and raspberries were planted in either field conditions or protected by high tunnels. Three cultivars of primocane blackberries and raspberries were planted either in field conditions or in high tunnels for both fall production, and the double cropping (fall and spring) system. Additional tests of pruning blackberries and raspberries to affect the time and synchrony of bloom and fruiting of fall-primocane cultivars were conducted.

Impact

It has been successfully 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 (>25F), while fruits 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 floricane and primocane types, grown in high tunnels produce more total fruit and larger fruit than plots in the field. Differences in pest infestation including weeds, disease, and insects have been observed in the tunnels. 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 reducing crop loss due to environmental circumstances, give economic benefits to growers.

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Funding:
USDA Integrated Organic Program; Organic Farm Research Foundation; Southeastern Small Fruit Research Consortium; National Bramble Growers Association; Division of Agriculture, University of Arkansas System

Tree fruit rootstock and cultivar evaluation for Arkansas conditions

Issue

The sustainable production of tree fruits for Arkansas, particularly peaches and apples, is dependent upon the selection of appropriate cultivars that are adaptable to Arkansas soil and environmental conditions, bloom at a time to minimize the risk of crop loss from frost, are resistant to key pests, and harvest at a time appropriate for the market. Currently there are dozens of rootstocks commercially available and hundreds of fruit cultivars from which growers can select for their orchards. However, not all cultivars are adapted and provide advantages to Arkansas fruit growers. Appropriate testing of tree fruit cultivar and rootstocks for empirical observation provides recommendations to growers to produce fruit, for markets to have fruit, and thereby provides consumers fruit for their diet from a local food system.

Action

Peach and apple rootstock and cultivar testing are conducted at experiment station locations in Fayetteville and near Clarksville. Tree fruit cultivar testing in Arkansas is conducted in conjunction with the national project, "NECC1009: Multidisciplinary Evaluation of Tree Fruit Cultivars" (http://nimss.umd.edu/homepages/home.cfm?trackID=7336)

Tree fruit rootstock testing is conducted in conjunction with the national project, "NC-140 Improving economic and environmental sustainability in tree fruit production through changes in rootstock use (http://www.nc140.org/)."

Peach and apple rootstocks are evaluated for tree size, stability, environmental tolerance, mortality, time from planting until production, and effects on fruit productivity and quality. Trees are planted in replicated blocks with data compared to performance at numerous locations in North America to develop an understanding of regional adaptability and performance. Peach and apple cultivars are tested with multiple trees for multiple years and tree characteristics such as time of bloom, annual bloom, fruit set, yield, insect damage, and disease susceptibility are measured annually. Fruits are harvested and more than 20 fruit-quality characteristics are measured.

Impact

Of the many rootstocks and cultivars tested in Arkansas, only a few are adapted to the unique circumstances of environment. Therefore, a primary impact of this research is to eliminate from consideration those rootstocks and cultivars that over the long term demonstrate that they should not be grown. Likewise, some cultivars and rootstocks perform consistently well in this environment and become the core of a recommended set of cultivars offering growers choices of season of harvest, fruit quality, and fruit for different uses such as processing or fresh consumption, and for different markets such as direct retail or wholesale. A third group of rootstocks and cultivars are those that may be useful given appropriate modifications in management, or special circumstances of location, microclimates, and soils. The testing of rootstocks and cultivars becomes the empirical basis from which recommendations for both commercial growers and homeowners are made.

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NECC1009 Regional Project : Multidisciplinary Evaluation of Tree Fruit Cultivars"
http://nimss.umd.edu/homepages/home.cfm?trackID=7336;
NC-140 Regional Project. Improving economic and environmental sustainability in tree fruit production through changes in rootstock use http://www.nc140.org/;

Funding
Division of Agriculture, University of Arkansas System

Effect of seeding pattern and rate on soybean growth and yield

Issue

Soybean seeding patterns and rates that would provide increased productivity are of great interest to soybean producers. Various seeding patterns and rates are used to achieve profitable yields by mid-southern U.S. soybean producers. An alternative seeding pattern has begun to gain interest among producers in which two rows, 19 cm (7.5 in.)

apart, are seeded with each set of rows separated by 97 cm (38.2 in.). This pattern is typically know as a twin-row system. Research was conducted by the University of Arkansas, Division of Agriculture in two separate trials to investigate the feasibility of this new system and other traditionally used soybean seeding patterns and rates in Arkansas.

Action

Both trials were conducted at the University of Arkansas Northeast Research and Extension Center in Keiser, Ark. A randomized complete block arranged in a split-plot experimental design with four replications was used for both trials. Trial 1 main plot consisted of three soybean maturity groups (MG) (MG III, MG IV, and MG V). The sub-plots consisted of row spacings (97-cm single-row, 19-cm twin-row spacing with each set of twin-rows separated by 97-cm). The sub-sub-plot consisted of soybean seeding rates (90, 112, 135, 157, and 179 kg/ha). Trial 2 main plot consisted of three soybean seeding patterns (18-cm, 38-cm, and 19-cm twin-row spacing with each set of twin-rows separated by 97-cm). The sub-plots consisted of seeding rates (112, 146, and 179 kg/ha). Only a MG IV soybean variety was seeded in this trial. Numerous data sets were developed from both trials.

Impact

Greater pod numbers per plant were observed for the MG IV and V soybean varieties compared to the MG III soybean variety in Trial 1. The 97-cm single row seeding pattern provided greater soybean pod numbers per plant compared to the twin-row seeding pattern in Trial 1. Seeding pattern did not influence pod numbers per plant in Trial 2. In Trial 1, greater pod numbers per plant were observed with lower seeding rates; however, no differences were observed for seeding rate in Trial 2. The twin-row seeding pattern yielded greater than the 97-cm single-row seeding pattern in MG III and IV soybean varieties, but no difference was observe in MG V soybean variety in Trial 1. In Trial 2, the 18- and 38-cm seeding pattern yielded greater than twin-row seeding pattern. Seeding rate did not influence yield in Trial 1; however, yield did increase with increasing seeding rate in Trial 2. Data indicate the feasibility of a twin-row seeding pattern in a soybean production system in which growers may wish to utilize a wide-row seeding pattern system. The twin-row seeding pattern increased yields for MG III and IV soybean compared to the 97-cm single-row pattern in Trial 1. However, narrower row-seeding patterns increased yield for the MG IV soybean in Trial 2 compared to the twin-row pattern.

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Funding

Arkansas Soybean Promotion Board; Division of Agriculture, University of Arkansas System

Management of black root rot, caused by *Thielaviopsis basicola*, on cotton using seed treatments

Issue

Thielaviopsis basicola, the cause of black root rot on cotton and numerous other crops, is a widespread pathogen in Arkansas. It is present in about 70% of cotton fields in the state. The disease reduces plant growth and development early in the growing season, delaying crop development and reducing yields. This pathogen is difficult to control since resistance is not available and long rotations out of cotton are not practiced. Seed treatments are universally used on cotton, but are not targeted at the management of black root rot. Myclobutanil (Systhane or Nu-Flow M) and triadimenol (Baytan), two triazole fungicides, have been shown to have some efficacy for the control of black root rot. The rates of these fungicides used on cotton, however, are directed at the control of *Rhizoctonia solani* and are generally not used at rates considered sufficient to provide significant control of *T. basicola*. Recently, acibenzolar-S-methyl (Bion), one of the systemic acquired resistance (SAR) chemical inducers, has been shown to reduce black root rot on cotton and was registered recently on cotton in Australia.

Action

The value of seed treatment with triazole and host-resistance-inducing chemicals was examined for black root rot control on cotton caused by *Thielaviopsis basicola* in both artificially and naturally infested soils. In artificially infested soil, Systhane (myclobutanil) reduced root discoloration by greater than 80%. In naturally infested soil, myclobutanil was effective in reducing root and hypocotyl discoloration over a wide range of soil population densities. Treatments containing high rates of myclobutanil provided greater reductions in disease. Bion (acibenzolar-S-methyl) applied to the seed reduced black root rot by 39 to 64% and 12 to 38% under low and high populations of the pathogen, respectively, in artificially infested soils. Rates of acibenzolar-S-methyl did not differ in efficacy. In artificially infested soil, root colonization by *T. basicola* was significantly lower when seed were treated with both myclobutanil and acibenzolar-S-methyl than with either chemical alone indicating control can be enhanced by using more than one chemistry. In naturally infested soil under low (24 CFU/g soil) and high (154 CFU/g soil) populations of *T. basicola*, a combination of myclobutanil and acibenzolar-S-methyl resulted in the lowest root discoloration and colonization. The nematicide seed treatment abamectin improved the control of black root rot in the presence of *Meloidogyne incognita*. Using selective media to quantify the colonization of the root system by *T. basicola* allows the pathogen's importance to be evaluated in the presence of other pathogens that contribute to the seedling disease complex on cotton.

Impact

This research has shown that triazole and host-resistance-inducing chemicals used as seed treatments are effective for the control of black root rot on cotton. In addition, it documents the additive effects of using these chemicals, which have rarely been shown for soilborne pathogens. This research will help producers make decisions on chemical seed treatments for cotton in Arkansas.

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Funding
Syngenta Crop Protection, Inc.; Division of Agriculture, University of Arkansas System

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 are essential. Stands and yields are further reduced by seedling diseases that have even more impact when low-vigor seed are planted under stressful environmental conditions. Unfortunately, growers rarely know the vigor of the seed they are planting. To fight seedling diseases and improve stands, growers use a variety of seed treatments, but these treatments vary in effectiveness depending on the type of soil, the planting date, and the pathogens that are attacking the seed and seedlings. Knowing which seed treatment to use and when to use it will improve yields and save growers money.

Action

The most commonly available seed treatments, some with activity against specific pathogens and some with a broad spectrum of activity, were compared at three locations in Arkansas (Keiser, Stuttgart, and Hope) 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

Broad spectrum seed treatments resulted in the highest stands and yields at all locations and at all planting dates, although these improvements were not observed in every test. Improvements in stand and yield occurred most often in the April and June plantings when the seeds were stressed by either cold or heat, but were also seen in the May plantings. Fungicide seed treatment improved stands and yields with seed of all qualities, but the impact was greatest with poor quality seed. Isolations from rotted seeds and from seedlings in the growth chamber tests showed that *Fusarium* spp., were the most common pathogens recovered from rotted seed while *Pythium* spp. were the most common isolated from seedling roots. Economic analysis of our previous field data by Michael Popp showed that ApronMaxx + Dynasty + Cruiser gave the greatest economic return of all seed treatments tested.

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. This will help us direct future research.

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Funding
Arkansas Soybean Promotion Board; Division of Agriculture, University of Arkansas System

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 is the planning tool for determining appropriate land application rates of poultry litter, has not been endorsed by the Division of Agriculture, University of Arkansas System due to a lack of consensus science. Settlement Agreements between various entities in Oklahoma and Arkansas and pending litigation mandate that a revised P Index be developed and adopted by all stakeholders.

Action

Division of Agriculture, University of Arkansas System researchers and extension personnel collaborated with vested state and federal agencies in developing a state-of-the-science revised P Index acceptable to all stakeholders.

Impact

A single risk-assessment and nutrient-management planning tool, endorsed by the Division of Agriculture and state and federal agencies, that is consensus science-based will be developed and implemented.

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Funding
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Estimating the economic value of rice as a function of harvest moisture content

Issue

Determining the optimal moisture content (MC) to harvest rice is a crucial decision for producers. Rice milling quality is typically maximized at grain MCs that incur high drying charges. Drying charges are typically applied on a progressively-increasing scale based on the MC of a rice lot. It is vital to rice producers and to cooperatives to determine the MC at which the economic value of rice is maximum, taking into consideration drying costs and potential pre-harvest milling quality changes.

Action

A five-year data set comprising the milling qualities and harvest MCs of 139 samples of eight cultivars harvested over a range of MCs at 11 southern U.S. locations was utilized. For each data point, the drying costs corresponding to the sample MC was computed using a typical commercial drying fee schedule. Additionally, the gross value of the rice corresponding to the sample milling quality was computed based on head rice prices of $16.50, $18.00, and $19.50/cwt (100 lbs) and broken prices of 60, 70, and 80% of the head rice values. A rough rice mass of one cwt at 12.5% MC was used as the basis for calculating rice gross value. To allow drying cost computation, the "green" mass at the harvest MC of the sample was calculated based on the one cwt at 12.5% MC. The net value (NV) of the rice was computed as the difference between the gross rice value and the drying costs. A quadratic relationship was used to characterize the change in NV across harvest MC; this relationship was due to the fee structure for commercial drying costs and the quadratic nature of head rice yield changes with harvest MC.

Impact

In all instances, the optimal harvest MC to maximize head rice yield was greater than the harvest MC corresponding to the maximum NV. Maximum head rice yields generally occurred at harvest MCs ranging from 19 to 22% for long-grain cultivars and 22 to 24% for medium-grain cultivar Bengal. However, depending on the head rice yield vs. harvest MC relationship, the harvest MC at which NV was greatest generally ranged from 16 to 20% for long-grain cultivars. An analysis was conducted to determine the economic effects of delayed harvesting vs. harvesting at optimal harvest MCs. For typical, highly "parabolic" head rice yield vs. harvest MC relationships, the NV of rice harvested at 14% harvest MC as opposed to that at optimal levels near 17 to 18% MC was approximately $0.82/cwt less if the price of broken was 60% of the head rice price, and $0.59/cwt and $0.38/cwt at 70% and 80% broken values, respectively. As the price of broken decreases, the NV of the rice at lower harvest MCs is greatly affected, but at higher harvest MCs, the price of broken had little effect on NV, owing to the relative absence of broken at higher harvest MCs. For cases in which head rice yields did not vary tremendously with harvest MC, harvesting at the 14% MC level showed NVs that were $0.21, $0.16, and $0.11/cwt lower than those at optimal harvest MCs for broken prices of 60, 70, and 80%, respectively.

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

Potassium fertilization of rice influences yield and stem rot severity

Issue

Potassium is sometimes referred to as the 'plant health nutrient' because plants deficient in potassium tend to have greater disease incidence and severity than plants having sufficient potassium nutrition. Potassium deficiency of rice and soybean is a problem on many silt and sandy loam soils in eastern Arkansas that appears to be increasing due to higher yielding crops. Potassium-deficient rice also tends to have high levels of stem rot, which is present in about 90% of the rice fields in Arkansas. The primary issue is whether stem rot can be adequately suppressed or controlled by judicious use of potassium fertilizer and/or fungicide.

Action

Research trials were first initiated in 2006 to examine the relationships between potassium fertilization, stem rot, and rice grain yield. A long-term, K-fertilization trial was established at the Pine Tree Branch Station, cropped to rice and soybean, and different rates of K fertilizer were applied to the same field area annually. In 2006 and 2008, years when rice was grown, rice yield and stem rot were evaluated in soils that had received annual K rates ranging from 0-160 lb K_2O/acre. Additional trials investigating the interaction between fungicide rate and K application rate and time were initiated in six grower fields having low and medium soil-test K levels in 2007 and 2008. Quadris fungicide (0 and 12.8 oz/acre) was applied at panicle differentiation to plots that had received 0, 60, or 120 lb K_2O/acre at one of three times including preflood, midseason, or late boot stage. Stem rot severity, rice grain yield, and plant potassium nutrition were evaluated.

Impact

In the seventh year of the long-term fertilization trial, stem rot was consistently worse in soil that had received suboptimal (≤40 lb K_2O/acre/year) and sometimes intermediate (80 lb K_2O/acre/year) annual rates of K fertilizer. Rice grain yields were usually maximized by annual applications of >80 lb K_2O/acre/year. Maximal yield losses attributed to inadequate K fertilization were 30 and 87 bu/acre in 2006 and 2008, respectively. The grower field trials showed that rice

yields were greatest and stem rot was least severe when K was applied preflood. The lowest yields and most severe stem row occurred when no K was applied or K application was delayed until boot stage. Furthermore, data showed a trend for fungicide to make the greatest difference in rice yields when no K was applied or K was applied at the mid-season and late boot stages. Overall, these results indicate that timely application of recommended K-fertilizer rates facilitate the production of high rice yields, reduce stem rot incidence and severity, and thus, may reduce the need for fungicide use. Furthermore, results suggest that a portion of the rice yield loss attributed to K deficiency is from increased disease.

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Funding
Arkansas Rice Research Promotion Board; Division of Agriculture, University of Arkansas System

What is the commercial fertilizer equivalent of fresh and pelleted poultry litter for warm-season forages?

Issue

Poultry litter has been applied to pastures and hay fields in western Arkansas as a fertilizer to stimulate forage growth for a number of years. Concerns of accumulation of P in soil and P and N runoff from fields receiving poultry manure have led to restrictions on how much poultry litter can be applied in regions designated as Nutrient Surplus Areas. To maintain sufficient forage production and ground cover, farmers will need to apply commercial fertilizers to replace or supplement the nutrients, especially nitrogen and potassium, once supplied almost entirely by poultry litter. To better manage the N in poultry litter and commercial fertilizers we need to know how much N is required to produce near maximal forage yields and the availability of N in poultry litter.

Action

Data from two multi-year research trials, one conducted between 1981-1985 and the other conducted from 2006-2008, were summarized to define the ammonium nitrate fertilizer equivalent of fresh and pelleted poultry litter applied to bermudagrass produced for summer hay production. Both projects compared season-total bermudagrass yields receiving a range of nitrogen rates from ammonium nitrate or fresh or pelleted poultry litter. Forage yield responses to each N source were then compared to define how much of the total N in poultry litter produced forage yields comparable to those produced with nitrogen applied as ammonium nitrate. Seven site-years of data for bermudagrass fertilized with 0-600 lb N/acre as commercial fertilizer nitrogen were evaluated to define the nitrogen rate that produces 90% of maximum forage yield potential.

Impact

Non-irrigated bermudagrass requires approximately 360 lb N/acre/yr to produce 90% of its yield potential. Yield of non-irrigated bermudagrass receiving no N was 1.6 ton/acre compared to 6.8 ton/acre for forage receiving 360 lb N/acre applied in three or four split applications. The ammonium nitrate fertilizer equivalent of fresh and pelleted poultry litter was similar for the first year of litter application and tended to increase with subsequent annual litter applications. Results suggested that for the first year litter is applied to warm-season forage about 60% of its total N content is equivalent to commercial fertilizer N (1.67 lb litter-N is equal to 1 lb of commercial fertilizer N). After two or three annual applications of litter, the ammonium nitrate fertilizer equivalent of fresh and pelleted poultry increased to about 70% (1.4 lb litter-N is equal to 1 lb commercial fertilizer N). These results should aid farmers and nutrient management planners in prescribing commercial nitrogen fertilizer rates to match the production needs of individual farms and accounting for the N availability in poultry litter that, when allowed, may be applied to some fields.

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Funding
Arkansas Fertilizer Tonnage Fees; Division of Agriculture, University of Arkansas System

Functional genomics of rice genes

Issue

Several rice genes isolated by the 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 carryout targeted gene silencing. This construct is a bit cumbersome to assemble, especially when working with multiple genes.

Action

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

Impact

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

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Funding
Division of Agriculture, University of Arkansas System; Arkansas Biosciences Institute; USDA/ CSREES/ Biotechnology Risk Assessment

Presence of unneeded DNA elements in transgene locus

Issue

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

Action

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

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.

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Funding

Division of Agriculture, University of Arkansas System; Arkansas Biosciences Institute; USDA/CSREES/ Biotechnology Risk Assessment

Effect of Arkansas turfgrasses on Japanese beetle survival

Issue

The Japanese beetle is a relatively new pest in Arkansas, as it was first discovered in 1997. It has been spreading throughout the state and is increasingly causing damage to horticultural plants, crops, and turf. The adult stage feeds on hundreds of different host plants, often causing unsightly or damaging defoliation. The Japanese beetle is difficult to control—both as larval stages found feeding on the roots of turfgrasses and as the adult stage on foliage. With the large areas of turfgrasses and pastures in Arkansas, vast numbers of adult beetles are produced. Adult beetles can fly up to 5 miles; thus, even if beetles are controlled in one yard, others can still enter and cause damage.

Action

A study was conducted to determine if common Arkansas turfgrasses differed in attractiveness or resistance to Japanese beetle egg-laying, and survival of eggs and larvae. We compared three warm-season turfgrasses: a Japanese lawngrass (Zoysia), common Bermudagrass, and hybrid Bermudagrass (Tifway), with a cool-season tall fescue (Millennium). Mated, adult, female Japanese beetles were exposed to these grasses in various choice experiments and the number of eggs laid in each turf and number of larvae surviving, were determined.

Results showed that turf type had a dramatic impact on the number of eggs laid by Japanese beetles. The tall fescue and the Japanese lawngrass (Zoysia) had significantly more eggs laid in them than the common bermudagrass, and the hybrid Bermudagrass, Tifway, had the fewest eggs laid in it by far. Even when only the three warm-season grasses were offered to the beetles, Tifway had far fewer eggs laid than common Bermudagrass or Zoysia. Similarly, significantly fewer larvae in Tifway survived to produce 2nd instar larvae. Survivorship was similar in the other three grasses.

Impact

The results clearly indicate that Japanese beetles oviposit less and survive less in certain turf cultivars. Thus, planting resistant or non-preferred turfgrasses would be an excellent means of reducing Japanese beetle numbers. Costs associated with Japanese beetle control could be reduced by planting resistant or non-preferred turfgrasses, such as Tifway, in Arkansas.

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Funding

Division of Agriculture, University of Arkansas System

Applied silvicultural assessment of upland oak-hickory forests and the red oak borer in the Ozark and Ouachita mountains of Arkansas

Issue

In 2000, the USDA Forest Service discovered tens of thousands of dead and dying red oaks in the forests of northern and western Arkansas. A significant cause of mortality in this "oak decline event" was a population explosion of a previously innocuous, native wood-boring beetle, the red oak borer. Because of the likelihood of serious and long-term changes to forest structure and composition resulting from the death of the red oaks, ecologists, foresters, landowners, outdoorsmen and environmentalists have voiced their concern about the underlying reasons for this beetle outbreak.

Action

We initiated research in 2001 to investigate the causes of this insect outbreak. Little existed in the way of previous research or literature to guide our efforts and we had to investigate the biology of the insect, create sampling methods to look at numbers of beetles within trees and in the forest, and begin to understand the biology of the insect and its interactions in the forest ecosystem.

Over the past eight years, we have gained new knowledge on many aspects of red oak borer biology and life history. We assembled a team of graduate students, technicians and scientists that include cooperators from the University of Arkansas, Fayetteville, the USDA Forest Service, the University of Arkansas Center for Advanced Spatial Technology, the University of Arkansas Forestry Resources Center, and the Universities of Kansas, Missouri, California and Illinois. We have felled and intensively examined more than 240 oak trees from a variety of stands in the Ozark National Forest and Ouachita National Forest. 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've 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've 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 or so years by new methods of tree-ring analysis. We have initiated 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 at consistently low levels. The 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. In 2001, rough population estimates suggest about 174 emerging red oak borer adults per tree. The emerging population in 2003 decreased to 32 per tree, and in 2005 was only 1.6 per tree, and the 2007 emergence was 1 adult per tree sampled. We believe that the outbreak is over.

Impact

Since the beginning of our red oak borer studies, my graduate students have completed five M.S. theses and two Ph.D. dissertations (and currently an additional 2 Ph.D. dissertations and one M.S. thesis are in progress) on red oak borer. Our research group has published more than 20 manuscripts and made over 100 oral presentations and posters describing this problem and highlighting the research we are conducting to understand causes and search for answers. What we have learned is of value to foresters managing the private, state, and national forests of Arkansas.

We learned that, throughout the forests, of the different oak species, northern red oaks experienced the greatest mortality and that mortality was higher in dense stands on ridges than on north, east, west and south-facing benches or in forests with lower densities of northern red oak. Red oak borer populations were also highest on ridges.

We learned that adult red oak borers fly over a period of ~6 weeks from late June through early August in odd-numbered years only, and that adult beetles fly near the tree canopy rather than close to the ground.

We discovered through analysis of bark and phloem tissues that northern red oak chemical defense mechanisms against red oak borer invasion are not different between healthy and unhealthy trees. When wounded, however, healthy trees were able to recover faster than unhealthy trees and thus may better tolerate invasion.

We developed molecular techniques to identify red oak borer larvae (as the immature stages of these beetles have few distinguishing physical features). We also developed molecular methods to survey for Armillaria, a root rot fungus and potential contributor to oak mortality, and determined that three species of this root pathogen are present in the Ozarks, the first confirmation of this fact. We do not yet know if that is significant in relation to tree mortality and the red oak borer outbreak.

We confirmed that the ubiquitous, large, black, carpenter ants that are common throughout our forests will eat red oak borer eggs and small larvae, and we used molecular techniques to confirm that even when populations of red oak borer were very low, these ants were finding and eating them. We are now working to discover whether these carpenter ants are equally common in all trees and forests stands, or if their abundance is influenced by tree species or size, or site or stand conditions such as controlled burns.

We examined previous red oak borer emergence holes, tree crown conditions and site aspects and correlated these forest and tree attributes with the presence or absence of black carpenter ants. We discovered that black carpenter ants are more frequently found on trees with low levels of previous red oak borer infestation versus those trees with previously high infestations. This suggests a potential role for black carpenter ants in the dynamics of red oak borer populations, but more research is needed to confirm this.

We found that phloem thickness was probably not an important factor limiting larval success, but that sapwood thickness was greater in more vigorous hosts, which were least suitable for borers. Host suitability factors appear to be important for both colonization and larval survival within trees, as severely infested trees were attacked more often and contained greater numbers of emergence holes than those that were lightly infested. Borer survival was reduced in severely infested trees from the outbreak cohort compared to the declining cohort, which suggests that one or more host suitability factors changed between cohorts.

We now have preliminary GIS-based hazard models that will help predict those forest conditions that are most susceptible to red oak borer outbreaks. We have a website on a CAST server that will ultimately deliver hazard maps, GIS models, and key field and ancillary data to landowners and the public. The information will be presented efficiently so that zooming in and out at multiple scales will be facilitated. The website will employ visualization technology such as Google Maps and Google Earth. This will more efficiently allow us to present hazard rating maps and field photographs spread over a large area, as well as detailed visualization of both terrain and forest, to enable forest managers and landowners to determine their level of forest-stand hazard with regard to red oak borer outbreaks.

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Herpetological community composition and habitat: Relationships on an industrial forest

Issue

Over the last few decades amphibian and reptile populations have experienced global, national, and regional declines. Amphibians and reptiles are considered good indicators of forest ecosystem health due to their sensitivity to habitat alteration, pollution, climate change, and disease. Understanding how forest management activities affect reptiles and amphibians can provide information to enhance knowledge for future forest management decisions. However, little is known regarding habitat parameters that may influence herpetological populations. Our objective was to characterize herpetological community composition and diversity among different forest cover types and forest management treatments, and to identify habitat parameters that influence amphibian and reptile occurrences.

Action

A study of amphibian and reptile communities was conducted on the Moro-Big Pine Conservation Area and adjoining Potlatch Forest Holdings lands in Calhoun County, Arkansas. Sets of three sampling plots were located in 6 stand types: uneven-aged stands with no silvicultural activity in the past 10 years, uneven-aged stands that had one prescribed burn, uneven-aged stands that had an aerial herbicide application, 5-year old loblolly pine plantations with similar site prep treatments (spray-burn-plant), 24-year old loblolly pine plantations with similar site prep treatments (spray-burn-plant), and hardwood stream drainages. Area-constrained searches, cover boards, and pitfall arrays were used to sample amphibians and reptiles 2 times each during April through August. Habitat characteristics were quantified in the spring and summer for each plot. Over 500 individuals representing 38 species of amphibians and reptiles were recorded. This included 14 species of snakes, 10 species of frogs and toads, 4 skink species, 4 turtle species, 4 species of salamanders and newts, and 2 lizard species. Over 63% of all captures occurred in June and August. Preliminary indications suggest herpetofauna communities vary by treatment.

Impact

Increased understanding of the influence of forest management on herpetofauna can provide managers information to enhance ecological services from industrial forest lands. Additionally, sampling protocols implemented with this study provide a basis for long-term monitoring of herpetological communities.

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Diseases of grain sorghum

Issue

Arkansas continues to rank high in the U.S. in the annual production of grain sorghum. From 1997 through 2000, approximately 136,500 acres of grain sorghum were harvested in Arkansas each year. In 2003, the total estimated value of grain sorghum was $40,309,000. Grain sorghum also has intrinsic value as a crop as harvested grain and as a rotation with other crops to help producers control weeds, insects and plant diseases. However, yields per acre in the state have remained relatively low compared to other regions. Many plant diseases affect grain sorghum yields, reducing both yield and grain quality and in some areas of the state, yield losses due to diseases may range from 10-50% each year. Anthracnose, caused by fungus *C. sublineolum*, is the most important disease of grain sorghum in the state and we have routinely been called out to investigate or found instances of crop failure due to this disease each year.

Action

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

Impact

Information concerning the best management practices for production of grain sorghum is proving to be useful by providing reliable information to growers about the hybrids and practices that minimize the importance of diseases while increasing their yields and profit. We can now suggest simple rotations and careful selection of hybrids as effective ways to reduce the significance of diseases on grain sorghum in production. We have also found and identified nearly a dozen new and extremely virulent races of the anthracnose fungus in Arkansas that have never been described in the literature. These new races not only infected all known hybrids but were responsible for the outbreaks in Arkansas that were being reported each year and fit the observations that resistance was inadequate to control this disease within the state.

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False smut of rice

Issue

Arkansas ranks first in the U.S. for rice production. In 2003, 1.4 million acres were harvested for a total value of over $740 million. Plant diseases are critical actors in achieving and maintaining high seed quality and levels of productivity. In 1997 a disease called False Smut, caused by a fungus, was found in Arkansas for the first time. Though widely known in other parts of the world, little information is available to describe how the disease is dispersed from one location to another or how the fungus is able to infect rice plants. Additionally, little is known about how resistant our rice cultivars are to infection by the fungus although many, if not all, appear to be highly susceptible. In other parts of the world, this disease has already become very serious, reducing yields by as much as 50%, a potential loss of millions of dollars to Arkansas. The overall objectives of our research were to determine how the fungus initiates infection of plants and how the pathogen survives to cause disease each year.

Action

We inoculated roots, soil and foliage with spores of the fungus and examined their behavior on tissues. We found that the fungus infected roots directly from infested seeds and from soils. We also used polymerase chain reaction (PCR) to *track* the fungus within plants and found that the fungus was in all parts of the plants even when inoculated from soil. PCR is an extremely useful tool to measure how this fungus invades plants. We also found a new potential tool to help control this disease: a fungicide, used in a similar situation on another crop, effectively reduced infection of rice by false smut. In 2008 we also conducted comparative field and greenhouse studies on seed treatments with fungicides and found that fungicides applied to seeds prevented infection of seedlings in both instances. We also conducted field tests with healthy seeds planted in infested soils and found that seedlings were infected by resident spores found in soils even after two years.

Impact

Our PCR results clearly show for the very first time that the fungus is seed transmitted and that the fungus infects plants in many ways, including from spores in soil, without producing symptoms. Furthermore, infection has resulted in blanking of panicles produced by infected plants. We now also know that seed treatments work against this important disease and we now know also that spores found in fields are capable of causing this disease.

The impact of our work is that we now know and understand how rice is infected by this fungus and these facts permit us to develop more effective means in managing the dispersal of an emerging disease of rice in Arkansas. The results may also influence how producers grow rice for commercial yields in fields with a history of this disease.

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Adding value for the regional grape and wine industry

Issue

Many small to medium sized farms are finding it difficult to maintain economic viability through a traditional focus on livestock, poultry, or agronomic crops. Increasingly, these farms are exploring alternative or non-traditional crops as a way of increasing profitability of their farming operations. Wine and juice grapes are one alternative that holds considerable promise. On a per acre basis, vineyards can command returns that greatly exceed returns from conventional crops. Furthermore, grapes provide tremendous potential for value-added marketing opportunities at the farm level, thereby increasing the farmer's share of the consumer's dollar.

Action

With the aid of funding from the USDA, Division of Agriculture scientists are developing a comprehensive set of materials to address challenges confronting vineyard operators, processors, and wineries. These emphasize good agricultural and handling practices for grapes, yearly timetables for vineyard operations, and the economics of establishing and operating vineyards. Significant progress has been made towards completing easy to use budget templates that integrate a variety of economic and viticultural considerations and facilitate decision making by those new to the industry. In particular, insecticide and fungicide spray recommendations provided by cooperative extension services throughout the South and Midwest are being incorporated into the budget templates to provide a user-friendly means of evaluating the costs of different insect and disease control strategies. In February 2007, project participants presented findings on vineyard economics to several hundred participants at the Midwest Grape and Wine Conference. Work is also being done to address retail markets for grapes and grape products; assess the potential of high value products derived from grapes and grape by-products; and provide fundamental information about the legal, business, and technical aspects of establishing and equipping a winery.

Impact

There is a considerable interest in grapes and wine on the part of potential growers, entrepreneurs and consumers. The promise of this industry for agriculture in the South and Midwest is tremendous in terms of a high valued alternative crop for producers, the ability to add value locally, and the economic opportunities in rural areas that can be provided by farm-based wineries and processing enterprises. The impact of this project is to ensure that information and timely assistance is available to promote the development and increase the successes of the regional grape and wine industry.

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Economics of pre-harvest vineyard mechanization

Issue

Forty years of research at the University of Arkansas culminated in the development of the Morris Oldridge (M-O) system for complete vineyard mechanization. A patent was issued for the M-O System in 2002 and was licensed to OXBO International. A comprehensive examination of the economic consequences of this system under actual commercial conditions was needed to demonstrate the value of this research and to provide a better understanding of the potential of mechanization to increase the long-term profitability of grape production in the U.S.

Action

University of Arkansas System Division of Agriculture scientists collaborated with a large commercial wine-grape vineyard that had adopted the M-O system on significant portions of its acreage. Over the past three years, several visits to this vineyard were made to gather the information necessary to estimate the costs of mechanizing several labor-intensive pre-harvest operations. The vineyard manager emphasized that the ability to more consistently meet yield targets was an important advantage of mechanization. Budgets were prepared to compare production costs under mechanized and traditional hand-farming systems, and an additional economic model was developed to assess the value of flexibility inherent in mechanization.

Results of this study show that mechanization significantly reduces labor costs. Depending on the trellising system, mechanization can save anywhere from $273 to $611 dollars per acre in production costs. Results from the economic model indicate that the flexibility afforded through mechanization is also of substantial importance. Estimates range from roughly $100 per acre to over $400 per acre, depending on the trellising system, potential value of the grapes, and magnitude of yield risk.

Impact

Growers of premium wine grapes rely heavily on hand labor in vineyards. Scarcity of labor, increased costs of labor, and increased competition from producing regions overseas threaten the long-term competitiveness of the U.S. grape industry. Information generated under this project demonstrates that mechanization can play a crucial role in addressing these challenges and provides practical and timely information to growers that are considering the transition to mechanized farming systems.

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Evaluation of the economic benefits and costs of zero-grade rice

Issue

The majority of rice acres in Arkansas are flood irrigated using contour levee systems. Contour levee rice fields require large amounts of applied water to maintain a flood during the production season. Fields precision leveled to a zero-grade require significantly less applied water and provide significant savings in production costs relative to contour levee fields. However, zero-grade is a land improvement and requires a large initial capital investment, and much time may pass before economic benefits are received. The rotation chosen for the field after zero-grading also impacts the monetary benefit and the length of the investment's payoff period. This study uses a net present value (NPV) approach to evaluate the monetary benefits and payoff period of zero-grade management in rice production for different rotations.

Action

Precision leveling expenses were calculated based on phone conversations with farmers, land leveling professionals, and equipment dealers in Arkansas during 2006. Expense estimates were calculated for single and dual pan equipment and included fuel, labor, repair and maintenance, depreciation, and interest charges. All precision leveling expenses were calculated for varying volumes of soil moved per acre assuming 200 acres of land were precision leveled per year. Monetary benefits to zero-grade were defined as the difference in per acre net returns between zero-grade and contour levee management. Present values of monetary benefits to zero-grade were calculated for alternative plan-

ning horizons (years) assuming a typical rice-soybean rotation for contour levee management and either a three-year rice-rice-soybean rotation or a continuous rice rotation for zero-grade management and a discount rate of 7.75 percent. The NPV for each planning horizon was calculated as the sum of present values to zero-grade management less the initial per acre cost of precision leveling to a zero grade. The payoff period was determined as the end year in the planning horizon for which the NPV was greater than or equal to zero.

Impact

The results indicate that the amount of soil moved per acre greatly impacts the profitability of zero-grade management. The per acre initial cost of precision leveling to a zero grade increases as the amount of soil moved per acre increases, and the amount of soil moved may be too excessive to allow the practice to be profitable for every field situation in the long run. However, the results imply that greater cost efficiencies may be achieved for large volumes of soil moved using dual rather than single pan equipment. The results also indicate that the rotation chosen after precision leveling to a zero grade strongly impacts the monetary benefits and the pay-off period associated with zero-grade management. Net present values were larger and payoff periods were shorter for zero-grade when rice was grown continuously rather than rotated with soybeans following the land improvement.

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Selection of superior endophytes and tall fescue lines for improving resistances to drought and nematodes

Issue

Tall fescue, a widely grown pasture grass in Arkansas, normally contains a fungus called an endophyte, which produces ergot-alkaloid toxins that reduce animal production and profitability. The endophyte also provides some degree of protection to the plant for drought tolerance and nematode resistance. Little is understood of the physiological and genetic mechanisms that explain the beneficial traits of such endophytes. Unlocking the mystery behind these mechanisms would allow scientists to select endophytes that are both nontoxic to livestock and have superior drought-protection and pest-protection benefits.

Action

The second year of a field trial was carried out in northwest Arkansas in which tall fescue populations differing in summer-dormancy trait, and either with or without endophyte infection, were compared for drought survival and physiological traits pertaining to drought tolerance. Field trials were initiated at the USDA-ARS Small Farms Research Center to determine progress in selecting for drought tolerance in tall fescue. Some of the populations were selected for persistence in the absence of their native endophytes.

Impact

The second year of the field trial confirmed results from the first year: that the summer-dormancy trait was more important than endophyte presence in ensuring tall fescue plant survival during summer drought. This indicates that endophyte-free varieties of tall fescue could be developed that support excellent cattle production if they possess a high degree of summer dormancy. A patent was received (U.S. Patent no. 7,465,855) for four strains of endophyte that promote drought tolerance in tall fescue without causing fescue toxicosis in livestock. Such endophyte strains offer opportunities for promoting the sustainability of cattle, sheep, and horse production and health using low-cost, environmentally benign forage management systems.

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

Issue

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

Action

By collaborating with Josh Sakon in the Department of Chemistry and Biochemistry, we are conducting animal studies to demonstrate the efficacy of a novel compound PTH-CBD in the treatment of postmenopausal osteoporosis. PTH-CBD is a fusion protein of parathyroid protein (1-33) and immunologically inert collagen-binding domain (CBD). PTH-CBD binds to type 1 collagen and is able to stimulate cAMP accumulation via signaling of the PTH/PTHrP receptor. PTH-CBD is anabolic in bone shown by increases in BMD and alkaline phosphatase levels. The increase in BMD is greater than bisphosphonates marketed by various companies. PTH-CBD is more potent and results in more prolonged effect on bone mineral density (BMD) than does PTH(1-34). The objective of this study is to determine the efficacy of PTH-CBD to increase BMD and to determine its influence in bone microarchitecture in an osteoporosis restoration model.

Impact

When the above listed studies are completed, we should have a clear picture of the efficacy of PTH-CBD and pharmacokinetics in rodents and be ready to test it in primates. PTH-CBD may offer treatment for osteoporosis. Several drug companies are interested in finding the outcome of the study. A provisional patent on this was filed by the University of Arkansas.

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

Issue

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

Action

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

Impact

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

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The role of functional foods in combating obesity

Issue

Obesity is a multifactorial condition that is a major public health concern affecting all demographic segments of the population, independent of race, culture, and/or ethnicity. For decades obesity has been an epidemic in the United States (U.S.), and the proportion of overweight and obese adults in the population continues to rise. An alarming 34% of adults in the U.S. are currently obese, which is significantly greater than was reported a decade ago. Although, obesity is a major health problem in the U.S., there are no proven, long-lasting, and widely applicable approaches to weight loss. Obesity has been recognized as a national epidemic and it is anticipated that soon it will surpass smoking as the number one behavior-related cause of mortality among adults in the U.S. It is well accepted that nutrition plays a major role in the prevention and treatment of obesity.

Action

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

Impact

The findings of the study may provide evidence that certain foods can help reduce the complications associated with excess body weight. This will translate to decreased burden on our health care costs and loss of productivity costs. Furthermore, the findings are of commercial interest. Soybeans are major crops in Arkansas, if soy is shown to be beneficial in preventing obesity, the food industry can benefit by making healthy food products containing soy. This in turn can increase revenue in the state.

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Environmental triggers of autoimmune disease in susceptible individuals

Issue

Autoimmune/autoinflammatory disorders are chronic progressive diseases that are the result of a specific attack by the immune system against an individual's own body components. Autoimmune/autoinflammatory diseases typically are multifactorial disorders involving an inherent susceptibility and environmental factors that trigger their expression. While animal models that spontaneously develop autoimmune disease are relatively rare, there are several fowl models with a high incidence of spontaneously occurring autoimmune disease. One of these is the Smyth line chicken which develops autoimmune vitiligo, where pigment cells are lost due to autoimmune recognition.

Action

Based on efforts over the past decade by University of Arkansas scientists, the Smyth line chicken model has been well established as an animal model for spontaneous autoinflammatory/autoimmune vitiligo. Moreover, this animal model is emerging as a unique model to study autoimmune disease in general and to address the role of environmental factors in a genetically controlled disease. Unique features of this animal model include 1) the predictably high incidence of vitiligo (80-95% of Smyth line chickens are affected); 2) early onset of the disease (the majority of chicks develop vitiligo between 6 and 14 weeks of age); and 3) the easy, repeatable access to the autoimmune lesion (located in the growing feather). Together these characteristics provide the unique opportunity to study mechanisms involved in autoimmune loss of pigment cells prior to onset and throughout the progression of vitiligo. With the identification of an environmental trigger of Smyth line vitiligo, namely routine administration of live herpesvirus of turkey (HVT) at hatch to protect the chickens from Marek's disease, studies using this animal model can now be extended to include investigations into triggers of disease expression in genetically susceptible individuals. Without HVT administration, the vitiligo incidence drops to less than 20% in the Smyth line population. Recent investigations examining the effects of inflammatory agents (microbial cell wall products, inflammatory cytokines) in HVT-negative Smyth line chickens suggest an important role of inflammation in triggering the expression of Smyth line vitiligo.

Impact

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 humans and poultry.

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Body Measurement System reveals overweight and obesity patterns in Arkansan populations

Issue

Overweight and obesity have reached epidemic proportions in the United States. Recent reports indicate that Arkansas ranks seventh in incidence of obesity with more

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

Action

Two hundred and thirty-six (236) college-age students participated in the pilot study. Of those, 206 were female and 25 were male with 80 being 10-19 years of age, 128 being 20-22 years of age and 23 subjects being over the age of 23 years. Ethnic diversity was lacking in this group of volunteers with 86% being white and 14% being non-white. Body measurements were taken using the [TC]2 NX12 Body Measurement System. Body composition and BMI were measured by bioelectrical impedance analysis. A BIQ with additional questions was administered to evaluate body image perceptions. Results indicate that television was the primary source of diet and nutrition information. Eating habits had changed in five of eight students since entering college. Students reported that they snacked more, consumed more "junk" food, drank more alcohol, practiced binge eating habits and ate at restaurants more often than before entering college. Ten percent of the variation in weighed discrepancy scores was due to the following changes since entering college ($p<0.0001$): consumption of more junk food, television as the primary source of nutrition information, weight gain since entering college and the practice of binge eating habits. Data analysis on body composition and body measurements is in progress. The pilot study should be expanded to include a more ethnically diverse population.

Impact

A need has been identified in this undergraduate sample for nutrition-education and skills-development interventions to improve dietary habits and body image ideals. The results may be applicable to similar samples at some universities. Overall, knowledge gained from these studies will find direct application on eating behavior interventions. Interventions can be designed for maximum effectiveness through studying an ethnically diverse population.

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Evaluation of dietary supplement safety

Issue

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

Action

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

Impact

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

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Bitter melon (*Monordica charantia*) leaves are excellent sources of beta carotene and lutein phytochemicals

Issue

Bitter melon (*Monordica charantia*) is an important cultivated food crop and widely used as a vegetable in Asia. Its leaves and fruits have been used for traditional medicines for centuries. Many scientific researchers have shown that bitter melon has some medicinal properties such as anticarcinogenic, hypocholesterolemic and hypoglycemic. However, little scientific information is available on the phytochemical composition of bitter melon leaves that can contribute to nutraceutical and pharmaceutical health benefits. The effect of drying methods on the composition of specific phytochemicals is unknown.

Action

Bitter melon leaves at three maturation stages: tender, vegetable and yellow were harvested. Vitamin C, carotenoids, flavonoids and phenolic acids were determined by HPLC. The main phenolic components in bitter melon leaves were o-coumaric acid, gentistic acid, and naringin. The total phenolic contents of fresh and freeze dried leaves were 16.0-17.8 and 15.1-17.2 mg gallic acid equivalent/g (dry basis), respectively. Vitamin C contents of fresh and freeze dried leaves were 0.10-0.34 and 0.10-0.32 mg/g (as is basis), respectively. Total β-carotene contents were 39.8-110.9 and 30.4-110.2 μg/g (converted to fresh weight basis) for fresh and freeze dried leaves, respectively. Oven drying at 40°C resulted in a loss of approximately 20% of these two phytochemicals.

Impact

Among the fresh leafy vegetables kale and spinach are considered to be excellent sources of β-carotene and lutein. The β-carotene and lutein contents in bitter melon leaves are approximately two and six times higher than those in spinach or kale. Bitter melon leaves can be a potential natural rich source of phenolics, β-carotene and lutein nutrients that have specific health benefits.

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Gastrointestinal-resistant rice bran peptides inhibit proliferation of colon and liver cancer cell lines

Issue

As cancer illnesses provide predicaments with conventional therapy, interest has increased in basic and applied research on nutritional and molecular interventions as alternative treatment options. As a result, many are supplementing traditional health care by turning to nutraceuticals and functional foods.

Bioactive compounds, particularly peptides that are broken down from proteins available in foods have been documented to possess anti-disease characteristics. The increasing knowledge of peptides with anti-disease properties like anti-hypertensive, antimutagenic, and anticancer has created commercial interest in using them as functional ingredients in food products. So far bioactive peptide research has focused primarily on animal, fish, and dairy proteins. Peptides from animal origin are often not desirable for disease, and religious reasons. Cereal proteins particularly have been utilized to obtain hydrolysates and peptides for testing against disease attributes like anti-hypertensive or anti-cancer etc.

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

Action

Arkansas is ranked number one in the production of rice, and rice bran is a cheap co-product of rough rice milling. Rice bran is primarily used as animal feed, and to extract oil which is used as cooking oil. Rice bran has nearly 20% protein and could be a source of bioactive peptides. In this research project, rice bran was used for preparing peptides with an intention of proving the benefits in controlling cancer cell growth. The rice bran containing protein was directly hydrolyzed using food grade enzymes to prepare peptides. These were treated with simulated gastro-intestinal juices before fractionation and collection according to their molecular sizes using ultra-filtration technique. The different sized peptides were tested for bioactivity by cell culture techniques to assess their ability to control cancer cell proliferation.

Impact

There is an increasing commercial interest in the production of economical biopeptides from proteins. Rice bran, being a good source of bioactive peptides, makes it a high-value crop co-product. We have demonstrated that GI-resistant <5 and 5-10kDa bran peptide hydrolysates inhibit the growth of Caco-2 (colon) cells by 80%, and <5 kDa fraction to inhibit growth of HepG2 (liver) cells by 50% compared to controls, and nonresistant fractions. Cell survival effects on purified peptide from <5kDa fraction on HepG2 cells showed 20 fold effective growth inhibition better than genistein (a known anti-cancer compound), while on Caco-2 cells the peptide showed 3 fold growth inhibition better than genistein. This could translate to a cheaper natural alternative source as treatment against human colon and liver cancer over genistein or other synthetic anti-cancer drugs,

which are not only expensive but also may impart side effects. Besides, the cost of commercial peptide hydrolysates and drugs having health benefits are currently sold at $50.00-100.00 for 5-25 mg. Our peptide could be relatively cheaper (estimated cost ~$1.00/mg) and as effective against cancer.

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Value-added anticancer peptide from high-oleic-acid soybean meal

Issue

Soybean seeds are grown primarily for oil in the U.S. Recent advances in plant breeding techniques promoted the production of oleic-acid-rich soybeans. High oleic acid in the soybean oil promotes the shelf life of food products. After the oil extraction, the protein-rich residue from the high-oleic-acid soy seeds is chiefly used as a meal in animal- and poultry-feed ingredients. Protein extracted from soy seeds has been attributed with the highest quality among vegetable proteins and is an excellent alternative to animal protein when intended for a vegetarian diet. Studies are being proposed and conducted to find biological molecules that can alter cancer-cell growth and prevail in controlling the spread of cancer in the human body. Our research objective is to prepare bio-active peptides from the high-oleic-acid soy meal that have anti-cancer activity and could be added as ingredients in food systems.

Action

Soybean meal has approximately 60% protein, 30% carbohydrates, and 1% oil. Soybean meal from three selected cultivars with varying oleic acid content viz., R95-1705, S03-543CR, and N98-4445A, was used in preparing peptides and anti-cancer property was studied. Seeds were ground, de-fatted, and amino acid contents were analyzed. The protein was extracted and digested under specific conditions using a food-grade enzyme, Alcalase, and the resultant hydrolysates (protein fragments) were tested for gastrointestinal juice resistance before fractionating them into molecular sizes of <5 kDa, 5-10 kDa, and 10-50 kDa. The 5-10 kDa molecular sized peptides from R95-1705 had 52% inhibition, while 10-50kDa peptides from S03-543CR and N98-4445A cultivars were found to have 70% inhibition on controlling liver cancer cell growth. This was a significant achievement leading to further research into purification of the peptides with the beneficial activity.

Impact

Studies have shown that bio-active compounds are very effective against certain major human diseases like cancer, hypertension, obesity, diabetes etc. Soybean-meal processing has accrued the reputation for being a cheap source of bioactive peptides. This will result in value added to the soy production system. Soy peptides with anti-cancer activity from this research would have a major impact on the health industry. The farmers who cultivate soybeans can gain extra profit due to the results from this research. Fortification of food products with the bio-active peptides from soy would be beneficial for the food industry by increasing marketability. Success of this research will revolutionize the concept of preparing peptides with certain metabolic activity against human disease and promote further study of value-added products from soy meal.

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Extrusion processing of blueberry pomace increases bioactive pyrocyanidin byproducts

Issue

A considerable amount of waste material (pomace) is left after commercial juice extraction. The pomace is a rich source of flavonoids, including procyanidins that consist of monomeric, oligomeric, and polymeric catechins. Procyanidins possess antioxidant, anti-inflammatory, antibacterial and anti-arthritic activities and may play an important role in the prevention of heart disease, skin aging, various cancers, and type-2 diabetes. The effective recovery of procyanidins from blueberry pomace as well as other fruit byproducts could provide new value-added products with health-promoting properties. Unfortunately, the oligomeric and polymeric forms of procyanidins are poorly absorbed relative to the smaller monomers and dimers. Novel methods are needed to convert large-molecular-weight procyanidins to the more bioactive low-molecular-weight forms.

Action

This study was undertaken to determine if extrusion processing, which involves shearing action at high temperature and pressure, could be an effective technology for converting oligomeric and polymeric forms of procyanidins to the more bioactive monomers and dimers. Extrusion variables temperature (160 and 180°C) and screw speed (150 and 200 rpm) were tested using mixtures of blueberry pomace with decorticated white sorghum flour at a ratio of 30:70 and 45% moisture. Extrudates were analyzed for procyanidin composition and content and compared to non-extruded samples. Extrusion of blueberry pomace increased the monomer, dimer, and trimer contents considerably at both temperatures and screw speeds. The highest monomer content, obtained at 180°C and 150 screw speed, was 84% higher than the non-extruded control. Significantly higher levels of dimers and trimers were also obtained under these conditions. The increases in low molecular weight procyanidins

apparently were the result of reduced polymer content, which was 40% lower than the non-extruded samples.

Impact

Extrusion processing can be used to increase levels of the bioactive procyanidin monomers and dimers in blueberry pomace, and the technology may be applicable for other procyanidin containing fruit and fruit by-products. We are currently investigating if extrusion increases the bioavailability of procyanidins in animal models, and if increased absorption of monomers and dimers increases insulin sensitivity, a key step in the prevention and management of type-2 diabetes.

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Impact of close, personal relationships on aging rural residents' quality of life

Issue

Previous studies have found that depressive symptoms among older persons have significant personal and social costs. For example, greater numbers of depressive symptoms are related to more rapid physical decline and earlier death. Also, depressive symptoms of older persons are related to utilization of social services, such as hospital emergency departments, a greater likelihood of hospitalization, and the incurring of greater diagnostic test charges over a one year period. Social strains associated with depressive symptoms may be greater for rural areas than non-rural areas because, as compared to urban areas, rural areas are experiencing more rapid population aging, more physical health challenges, and fewer mental health resources. At the same time, a great deal of research has found that close personal and family relationships are an important buffer from depressive symptoms. It is not, however, clear how rural persons compare to non-rural persons in regard to availability of and efficacy of having close personal relationships. Because of personal and social costs of depressive symptoms, it is important to understand variations in the availability and efficacy of close personal and family relationships across rurality.

Action

To more fully understand how rurality was related to the availability and efficacy of close personal relationships in regard to the experience of depressive symptoms, data from a subset of participants in the Health and Retirement Study (HRS) were examined. These data are nationally representative and collect information on a great number of variables including health status and socioeconomic status. The data for this study included 1,250 individuals, all of whom were 65 years old or older in 2004, the year that the data were collected. Generally, this study found that rural persons reported slightly, but significantly, more depressive symptoms than others. At the same time, this study found that rural persons reported larger numbers of close friends, a greater perception of being able to rely on family members, more meetings with family members and adult children, and closer personal relationships with adult children. The study also found that the close relationships with friends and family members were important buffers to experiencing depressive symptoms and the efficacy of those relationships was constant across rurality. In sum, the study suggested that rural persons are more likely to have close relationships with friends and family than other older persons. Also, the study supported previous research suggesting that these relationships are important coping resources for older persons, but they are neither more, nor less, efficacious for rural than urban older persons.

Impact

As competition for public resources increases and the population ages, it is likely that family members will be increasingly relied on to provide for the physical and emotional needs of their aging family members. This study highlights the importance of maintaining those close relationships. More specifically, the study suggests that maintaining those relationships will have important personal, as well as social benefits. In terms of those social benefits, it would be expected that those persons who maintain close relationships with friends and family will utilize fewer social services, as well as incur fewer health-related costs. The research clearly suggests that family life educators who focus on intergenerational relationships are an important resource to the well-being of older persons.

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

Issue :

When self-assembling nanostructures for biological, medical, and electronic applications, if DNA oligonucleotides can form unplanned duplexes (cross-hybridizations), defects might result. Likewise, cross-hybridizations can produce errors in the results of DNA computations. Thus, there is a need for libraries of oligonucleotides that minimize cross hybridization.

Action :

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

Impact

The libraries of DNA oligonucleotides produced in our laboratory should be useful for a variety of biological, biomedical, and other applications, particularly as DNA-oligonucleotide building blocks for DNA-based computers and nanotechnology. The research has generated over four publications and presentations during 2008.

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A Safe and Secure Food System

Use of natural citrus compounds against common foodborne pathogens

Issue

Foodborne pathogens of greatest concern today include *Salmonella* spp., *Campylobacter jejuni*, and *Escherichia coli O157:H7*. Many consumers are demanding more "natural" compounds for use as antimicrobials in food, plus the demand for organic meats has increased. Organic meat producers are not able to use traditional antimicrobials and thus need more consumer-friendly antimicrobials.

Action

The overall goal in this research is to examine the efficacy of citrus-based antimicrobials as economical alternatives that would be readily accepted by both the organic processor and the consumer. Seven orange essential oils were tested: cold pressed Valencia orange oil, terpeneless Valencia orange oil, cold pressed orange terpenes, high purity orange terpenes, d-limonene, terpenes from orange essence, and 5-fold concentrated Valencia orange oil. An additional study was carried out to determine whether orange peel and orange pulp exert antimicrobial effects on *Escherichia coli O157:H7* populations that are found in cattle gastrointestinal tracts. The addition of orange pulp and peel to in vitro mixed ruminal microorganism fermentations demonstrated that both orange pulp and peel reduced *E. coli O157:H7*populations at least 2 $\log_{10}$ in mixed ruminal-fluid fermentations.

Impact

These studies demonstrated the potential of the selected commercial orange-oil fractions to serve as natural antimicrobials against *Salmonella* spp., *Escherichia coli O157:H7*, *C. jejuni*, *C. coli*, and *Arcobacter* spp. We also determined that orange pulp and/or peel included in ruminant diets could decrease foodborne pathogenic bacteria in the cattle's rumen.

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Natural antimicrobial compounds reduce campylobacter in poultry

Issue

Campylobacter is the one of the most commonly reported bacterial causes of human foodborne 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 at the University of Arkansas is at the forefront of investigating preharvest strategies to reduce *Campylobacter* contamination in poultry. One of our major focuses is evaluating and developing strategies utilizing natural antimicrobial compounds. We have been successful with numerous compounds including demonstrating the efficacy of bacteriocins (proteins naturally produced by bacteria that kill or inhibit the growth of other bacteria). Recently we have explored the effectiveness of caprylic acid, a natural fatty acid present in breast milk and coconut oil, which is a food-grade chemical approved by the FDA as Generally Recognized As Safe (GRAS). 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 that 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 a novel bacteria-vectored vaccine against *Salmonella*

Issue

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

Action

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

Impact

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

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Funding
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Nanoparticles-based fluorescent biosensor for rapid detection of *Listeria monocytogenes* in foods

Issue

Listeria monocytogenes is one of the major foodborne pathogens and has relatively high heat resistance and salt tolerance and the ability to grow at refrigeration temperatures and over a wide range of pH. The CDC estimates that 2,500 cases of human listeriosis occur annually in the U.S. with a case fatality rate of 20% that leads to an estimated 500 deaths per year with a projected cost of $233 million. The USDA/FSIS issued a zero-tolerance policy for *L. monocytogenes* in ready-to-eat foods. To control *L. monocytogenes* in foods and to meet the federal regulations, food industries need a rapid, sensitive, specific, and inexpensive method to detect *L. monocytogenes* in food products on production lines or even in real time.

Action

The objective of this project is to develop a nanoparticle-based fluorescent biosensor for rapid detection of *L. monocytogenes* in foods. The biosensor system consists of a novel nanobeads bioseparator, novel quantum dots biolabels, and a fluorescent detector. The nanotechnology-based biosensor is evaluated for the food industry to screen *L. monocytogenes* in poultry, meat, and vegetables, specifically ready-to-eat food products. The results showed that magnetic immuno-nanobeads could capture target, pathogenic bacteria in foods with more than 90% capture efficiency in 15 min, which is advantageous over magnetic immuno-microbeads as well as centrifuge and filtration. Quantum dots nanoparticles were coated with anti-Listeria antibody and used as fluorescence labels in the immunosensor, which gave more than 100 times fluorescence emission compared to common fluorescent materials used in immunoassays. The fluorescent intensity measured is proportional to the concentration of Listeria cells in a range of 1 to 106 CFU/ml. A totally automated instrument (which consists of a nano-bioseparator, a flow-through microfluidics chip, and an optical detector) has been designed and fabricated for this biosensing technology. Anti-*L. monocytogenes* monoclonal antibodies and rapid-growth medium are being developed to make the required specificity (strain level), sensitivity (1 CFU/ml), and time (less than 2 h). This biosensing method is also able to simultaneously detect multiple pathogens in foods.

Impact

The food industry and federal regulatory agencies can apply this novel biosensing method to food safety inspection and quality control to ensure food safety and security. Our society could benefit from this technology in terms of reducing foodborne diseases and consequently, related medical costs. Application of the new nanotechnology-based biosensor would enable the food industry to be benefited economically in terms of prevention of product recalls and international embargo associated with the microbial contamination of food products.

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Predictive models and quantitative risk assessment models for *Listeria monocytogenes* in poultry products

Issue

Listeria monocytogenes is one of the major human pathogens associated with poultry products, mainly due to microbial contamination, recontamination or cross-contamination during production and processing. The poultry industry needs more effective methods to identify microbial hazards, assess the risk in their HACCP programs and risk management, and evaluate intervention technologies applied to poultry production, processing, and handling systems.

Action

Experiments have been conducted to collect the data for *L. monocytogenes* on chicken products with various conditions (temperature, time, age of water, chlorine level, chemical spray and initial cell concentration). Predictive models have been developed for survival/growth/destruction of *L. monocytogenes* on chicken products. Experiments were also conducted for hatching process, providing the data on Listeria contamination of eggs and chicks. A cross-contamination model for poultry chilling process was also investigated. A quantitative risk assessment model has been developed for poultry production, processing, and distribution based on both collected and reported data using Monte Carlo simulation with @RISK software. The risk model can present the probability of microbial hazards in terms of percentage of contaminated carcasses or pathogen level of each carcass for given processing conditions. Sensitive analysis can also rank the major sources of microbial contamination or the critical control points in a poultry production, processing, and distribution system. Interventions can be evaluated using the risk-assessment model coupled with predictive microbial model. A website is available for the risk-assessment model developed in this research (www.uark.edu/ua/biorisk).

Impact

The predictive microbial models will provide poultry processors with a powerful tool to analyze the survival/growth/ death and cross-contamination of pathogenic bacteria on poultry carcasses and in processing water under various processing conditions. The microbial risk assessment model will assist the poultry processor in their HACCP programs and risk management in a quantitative way. In combination with on-line or real-time microbial detection technologies, the predictive model and quantitative risk assessment model could make on-line risk analysis available, which would greatly help the poultry industry in their decision making for food safety. Consumers will benefit from safer poultry products and society will benefit from reduced foodborne diseases and related medical costs.

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Electrostatic spray treatments with organic acids and plant extracts decontaminate *Salmonella* Typhimurium and *Escherichia coli O157:H7* in spinach

Issue

Fresh and fresh-cut fruits and vegetables are potential sources of *S.* Typhimurium and *E. coli O157:H7* infections. Following the recalls of spinach (July 2006, September 2006, August 2007) due to *Salmonella* and *E. coli O157:H7* contamination, concerns increased to find potent antibacterials. These microorganisms on the leaf surface are embedded in biofilms or attached as aggregates and are resistant to environmental stress and disinfectants. The conventional methods for reducing pathogens on fresh produces involve washing them with water or chemicals like chlorine, peracetic acid, acidified sodium chlorite, hydrogen peroxide or mechanical treatment of the surface by brush and spray washers. Chemical preservatives have also been used by manufacturers to extend the shelf life of the produce and prevent contamination. However, some of these food preservation systems can have undesired effects. This has led to the

developing interest in the efficacy of natural antimicrobial substances that will not only serve as a safe alternative for chemicals in maintaining the microbiological safety, but also provide fresher, additive-free, and more natural sensory attributes as food preservatives.

Action

Organic acids and salts are promising antimicrobial agents because of their acceptance in food products and low cost. In our laboratory, organic acids such as malic and tartaric acids and grapeseed extracts have been extensively studied to show bactericidal activities and can be incorporated into edible films for produce and meat. The optimal concentrations of combinations of organic acids (malic, tartaric and lactic acids) and grapeseed extract on inhibiting *S.* Typhimurium and *E. coli O157:H7* in spinach and the extent of disintegration of these biofilms on produce surface were investigated. Malic acid (2%) and grapeseed extract (3%) were found to have the best bactericidal effect on *S.* Typhimurium adhered to spinach.

Impact

As washing and rinsing do not completely decontaminate fresh produce such as leafy greens, microbial safety must be ensured at the selling point of produce. The combination of malic acid (2%) and grapeseed extract (3%) applied by electrostatic spraying, as determined in our study, can find applications to control and minimize *Salmonella* concerns on spinach. While heat treatments and chemical preservatives can affect the quality of produce, malic acid (found in apples) and grapeseed extract being natural additives, can decontaminate, extend the shelf life of produce, enhance produce freshness, and offer health benefits to consumers. This is the first novel approach of spraying antimicrobials electrostatically. Electrostatic spraying overcomes the limitations of poor surface coverage and runoff of spray solution that are characteristic of conventional spraying techniques. It confers a spatial deposition of the solution and improves retention of these atomized droplets and thus a long-term bactericidal effect. The synergistic combination of malic acid and grapeseed extract will lead to the development of an intervention strategy at the post-harvest level using multiple-hurdle technology for the long-term enhancement of food safety, preservation, and quality of fresh produce.

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Antimicrobial protein coating for meat products

Issue

Microbiological quality of meat products has been a great challenge to the meat industry since post-processing handling inevitably can re-contaminate the subsequent meat products posing a possible risk to public health. Such microbial contamination mainly takes place at the surface of meat products. Although, the use of antimicrobial interventions has been widely researched and proven to be effective for controlling pathogenic bacteria in meat, the rapid diffusion of active agents from surface to food mass limit the efficiency of controlling microbial growth on meat surfaces. Therefore, an active packaging system such as an antimicrobial incorporated protein coating could be an efficient alternative solution in which antimicrobials will slowly migrate to the surface of meat where the high concentrations of active ingredients are needed.

Action

Beef steaks obtained from biceps femoris muscles were inoculated with *E. coli* and *Salmonella* Typhimurium (107 CFU/g). The inoculated steaks (n=15) were dipped in gelatin with 0 (Gel), 1.5% (Gel+ 1.5% KL) and 3% (Gel+3% KL) potassium lactate or 3% potassium lactate (3% KL) for 1 min. Then the treated steaks and untreated inoculated control steaks (INCON) were packaged and displayed under simulated retail conditions and sampled on day 0, 1, 2, 3, and 7 for microbiological evaluations.

Impact

The tested antimicrobial treatments significantly reduced the microbial populations in inoculated beef. The results indicate that a gelatin-coating system with or without incorporation of potassium lactate may improve product safety and extend product shelf life efficiently. Further analysis is required to evaluate the effect of gelatin coating on sensory and instrumental color characteristics of coated meat.

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Arkansas Beef Council; Division of Agriculture, University of Arkansas System

Food safety and *Campylobacter jejuni*

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 effects 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

Research results show that *C. jejuni* attachment to surfaces is facilitated by pre-established biofilms and biofilms may be important in transmission and prevalence of *C. jejuni*. Stress adaptation also can enhance survival outside a host. Another study indicated that phenotype may play a role in colonization of chickens and virulence by *C. jejuni*. As much as 98% of bacteria found in the environment are in an adherent state, yet many studies utilize bacteria grown as free-swimming cells.

A virulence study showed differences of *C. jejuni* in attachment and invasion abilities to tissue culture cells dependent on culturing in broth or agar but differences were not as apparent as with a chick colonization study. Understanding differences in virulence and any basis for pathogenicity is strategic for finding targets for treatment. In order to understand the importance of cytotoxicity in *C. jejuni* pathogenicity, we compared the active subunit of CDT of isolates from poultry sources and clinical patients. Additionally, the significance of invasion in pathogenicity was also evaluated and correlated to toxin production. We found no correlation in invasion abilities and cytotoxicity and the results also indicated that *C. jejuni* may utilize more than one mechanism in causing disease and pathogenicity but is strain-dependent. Therefore, it would be necessary to target more than one gene to design a detection method that would be able to distinguish pathogenic from non-pathogenic *C. jejuni* strains. Work is in progress to determine antibiotic susceptibility patterns of *Campylobacter jejuni* isolates from humans and poultry before and after exposure to different stresses.

Impact

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

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Economics of regulating food recalls

Issue

Food recalls are a critical to keeping the nation's food supply safe. Recent high-profile food recalls have resulted in calls for increased oversight of the recall process, and several legislative proposals before the 110th Congress contain provisions that address the role of regulatory bodies in the recalls process.

Action

An economic model was developed to demonstrate the impact of recalls on food safety outcomes. The model shows that recalls are important for two reasons. One is that they help minimize harm when product failures occur. Another is that they provide financial incentives for the food industry to invest in safety. When recalls are justified they force food manufacturers to remove product from the marketplace so fewer people get sick. In these cases it makes sense that regulatory bodies should be granted more control of the recall process in order to improve the manner in which recalls are conducted. Such is the stated intent of most proposals for changing the food recall system. However, the model shows that recalls can be justified by their incentive effect alone. In fact, recalls can be beneficial even when the social value of the harm they mitigate is so small as to be less than the costs of carrying them out. In these cases, it is important that proposals designed to improve the recall process avoid unintended side effects. First, proposals should avoid redirecting regulatory resources towards recall oversight and away from other, more pressing, food safety priorities. Second, it is important to avoid creating an environment in which agencies face a greater need to justify their recall requests. When the mitigation value of recalls is small, this may inadvertently prevent the initiation of recalls that could otherwise play a positive role in aligning incentives for safety.

Impact

This project provides insight into the economic tradeoffs involved in firm and governmental policies towards food recalls. The direct impact is a meaningful contribution to a timely policy discussion that is of significant importance to food producers and food consumers alike.

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Greater Harmony Between Agriculture and the Environment

Environmental resource management to develop watershed technologies and management tools

Issue

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

Action

This research focuses on combining remote-sensing techniques with transport models to capture the dynamic soil erosion processes that affect water quality. One of the major research focuses is on identifying the source of the sediments in the deteriorated West Fork of the White River (WFWR) Watershed. We will be using aerial remote sensing combined with photogrammetric analysis to characterize stream bank erosion in selected reaches of WFWR Watershed. Similarly, we will be using remote sensing to quantify land use/land cover changes in the last 20 years and their impact on the upland contribution of sediments to the river using the annAGNPS model.

Impact

It is important to protect our natural resources for future generations. A clear understanding of the various sources of pollution of surface waters and the mode of action of these pollution sources is critical to develop remediation techniques or best management practices that would control the sediments based on the source of the sediments (stream bank vs. upland).

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Funding
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An ammonia emission mitigation system for commercial broiler houses

Issue

Air quality from confined animal feeding operations (CAFO) is an emerging issue that will affect the economic viability of animal agriculture all over the U.S. As a top poultry state, and home to several poultry integrators, Arkansas would be 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.

Action

This project aims at developing a simple and effective at-source mitigation system for ammonia emitted from commercial broiler houses. The mitigation system combines a water scrubber with a biofilter that would treat the exhaust air coming from fans. This mitigation system is non-hazardous, easily disposable and is expected to have minimal impact on water and air quality after disposal.

Impact

As a top poultry state in the U.S., Arkansas could be seriously impacted by the evolving air quality issues, if not addressed immediately. The ammonia emission mitigation system is expected to reduce the ammonia exhausted from the chicken houses by approximately 70%. Since ammonia is a trigger for secondary particulates, and cause serious environmental problems such as soil acidification and eutrophication, this system is expected to have major environmental quality benefits as well as bird and human health benefits.

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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

The focus of this research project is to generate value-added products from the two waste streams of cotton agriculture, the gin waste and bale wraps. Cotton gin waste is rich in natural ligno-cellulosic fibers that 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, the objective of this project is to evaluate the two waste materials for potential application in ligno-cellulosic composite (LCC) boards. We are also characterizing the burr and linters fraction of the cotton gin trash for chemical and physical properties, manufacturing LCC boards with various amounts of these waste materials as ingredients, testing them for relevant physical and mechanical properties, and comparing them to commercial composites to analyze their suitability in those applications.

Impact

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

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Funding

Cotton Inc.; Division of Agriculture, University of Arkansas System

Development of a distributed artificial neural network model for hydrologic modeling

Issue

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

Action

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

Impact

We are currently developing a new distributed ANN model, which is expected to have high accuracy and computational efficiency while accurately representing the spatio-temporal dynamics of rainfall-runoff processes. This model will be able to analyze the effect of various parameters on runoff process (sensitivity analysis), identify high-runoff-contributing areas and effect of land use/land cover changes on runoff processes. Such a model can be implemented relatively inexpensively and accurately to implement best management practices in critical areas in the watershed to reduce flow and erosion and to improve water quality.

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Rice fungicide use should depend on scouting

Issue

Fungicide use on rice in Arkansas has increased from about 20% of acres sprayed prior to 1997 to about 70% of acreage sprayed annually today. This represents an increased cost of production for the Arkansas rice crop of more than $16,000,000 based on an average 1.3 million acres of rice grown each year in the state. The basis for spraying has apparently switched from scouting and decision-making systems to preventative spraying, without any research foundation to support the latter. Growers, impressed by new fungicide technology introduced in 1997, started assuming that all applications were profitable while consultants have become more and more reliant on fungicides for late-season risk management–"just in case" to avoid any surprises.

Action

Over the past several years, faculty in the Division of Agriculture Department of Plant Pathology conducted replicated fungicide field trials using four types of rice cultivars at different locations around the state comparing preventative fungicide applications to no fungicide. At a few locations, up to 20 cultivars were inoculated with the sheath blight fungus and compared in replicated plots either treated or not treated (paired-plots) with a preventative fungicide over 3 years.

Impact

Results showed that semidwarf long grain rice treated preventatively either broke even or had a measurable yield and/or milling quality benefit about 75% of the time. Standard height long grain cultivars broke even or benefitted only 40% of the time, while medium grain and hybrid cultivars did not benefit from preventative treatments. In "paired-plot" studies, only semidwarf long grain and standard long grain cultivars had a measurable yield benefit from preventative treatments when inoculated, and milling quality benefit varied by year. Medium grain and hybrid cultivars rarely benefitted, even under inoculated conditions, and some long grain cultivars had marginal benefit from the fungicides. Results clearly showed that preventative fungicides did not always return a profit or even break even; in fact, sometimes there was a clear profit loss with this approach. Results were widely presented to growers and consultants and many audience members were surprised by these findings and indicated they would rethink fungicide use when informally interviewed. It is estimated that in an average year, with the current mix of semidwarf long grain, medium grain, standard long grain and hybrid rice cultivars planted in Arkansas–only about 20-40% of the acreage should be treated, if scouted. If growers and consultants employed an IPM approach and reduced sprayed acreage from the current 70% to 40%, the savings would be approximately $10,000,000–not counting environmental benefits from less fungicide application.

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Heating poultry houses with manure

Issue

Fuel for space-heating is the single largest operating expense for most poultry growers. Costs for propane continue to escalate and threaten profitability of many operations. Poultry litter can be viewed as a renewable biomass energy resource that is generated on the farm. Broiler litter has about 60-70% of the energy content of wood or sawdust. Combustion of poultry litter is being considered as a way to utilize this resource in an environmentally friendly way to reduce consumption of fossil fuels, propane, and natural gas.

Action

Biological engineers in the University of Arkansas System's Division of Agriculture have continued ad hoc testing of a broiler litter-fired furnace. A second generation prototype furnace, manufactured by an Arkansas company (Lynndale Systems of Harrison), was tested in 2008. The furnace sustained burns of 100% raw broiler litter. Combustion chamber temperatures were in the range from 600 to 1000°F. The improved furnace model delivered a peak heat output 300,000 btu/h, consumed litter at a rate of 110 lb per hour, and exhibited a system efficiency of about 65% in a short, steady-state test. The manufacturer has planned further design improvements so that a future commercial furnace should save enough natural gas or propane to pay for the biomass energy system.

Impact

The poultry industry has a need for multiple technologies to help respond to escalating fuel costs and continued environmental concerns. Litter to energy conversion is one idea that has great promise. The recent demonstration has shown that poultry manure can be combusted on-farm at rates over 1.5 tons per day to provide thermal energy needed for space-heating. Additional work is needed to test air

emissions and find markets for litter ash. If successful, adoption of this technology would not only decrease litter application in sensitive watersheds, but it would displace expensive fossil fuels (propane and natural gas) with a renewable biomass energy source found right on the farm.

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Value-added fertilizer from litter and biosolids

Issue

Regions such as Northwest Arkansas known for poultry production and rapidly growing municipalities have surpluses of broiler litter and municipal biosolids. While these materials are excellent fertilizers, their production is increasingly viewed as a liability and each substrate requires reformulation to products that are economically transportable from nutrient surplus regions to nutrient-deficient regions.

Action

Granulation, a new process cheaper than pelletization, was used in combination with litter, biosolids, urea, and various binding agents to produce a value added granulated fertilizer.

Impact

These materials were demonstrated to be comparable to commercial fertilizer in transportability and had less impact on water quality than commonly used fertilizers

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Funding

Division of Agriculture, University of Arkansas System

Soil-inhabiting mites in forest and agricultural settings in Arkansas and their potential for use as indicators of soil health

Issue

Little is known about the occurrence, abundance, and identity of soil invertebrates in the Ozarks and even less is known about mites in agricultural fields and the impact of management practices on these soil organisms. Additionally, very little information is available regarding the role these mites play in nutrient cycling and decomposition, pest and disease causation or mitigation, and what mite diversity may be necessary to produce the best soil conditions for agricultural systems. Knowledge of how mites affect soils, both good and bad, is necessary for developing successful management practices.

Action

A study was conducted to sample soil mites present throughout Arkansas habitats including forests, grasslands, pastures, conventional agricultural fields, and organic systems. Collection effort involves gathering soil and decomposing matter on the soil, extracting all living arthropods from this material and then sorting them into different groups. Eventually the different mites present will be identified to whatever level possible, such as genus or species. Theses collections efforts began in large, healthy forests in Buffalo National River and Devil's Den State Park late this Fall. Additional sampling will commence as spring approaches and arthropods become more active. We plan to sample all desired habitats between April and September.

Impact

This study will establish an extensive reference collection of Arkansas soil mites and provide an invaluable resource for any future researchers interested in soil mites. Additionally, this will allow us to document the abundance and species diversity of mites in Arkansas soil. The results may also allow us to make comparisons among the numerous mite groups found in the system and lead to correlations between soil health and the mite communities present. Finally, this study will lay the foundation for determining the role of mites in soil systems and the direct or indirect impact they have on soil health and regeneration in future studies. This will require more specialized studies on the soil itself (e.g., pH, organic content, nutrient loads) and proper collaborations will be established to handle these research aspects.

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Role of vitamin C in plant-insect interactions

Issue

Vitamin C (ascorbic acid) is a critical antioxidant in plants, and also an important dietary requirement for human health. Furthermore, enhancing vitamin C content in plants appears to increase tolerance to abiotic stresses such as salinity. Therefore, there is considerable interest in new approaches to increase vitamin C content in crops. However, the impact that this would have on pests, such as herbivorous insects has never been examined.

Action

In collaboration with Argelia Lorence at ASU, I am using tomato and *Arabidopsis* as model systems to investigate the role of vitamin C in plant-insect interactions. To date, we have found that feeding damage by caterpillars (*Spodoptera exigua*) significantly reduces vitamin C content in foliage. In addition, we have assessed caterpillar performance on *Arabidopsis* lines with modified (high and low) vitamin C content, and preliminary data suggest that plants with high vitamin C content suffer less feeding damage and are less suitable hosts for caterpillars than normal (wild-type) or low-vitamin C plants.

Impact

These findings suggest that enhancing vitamin C content in plants could have benefits for crop protection. We are currently working to develop tomato lines with enhanced vitamin C content.

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Effluent discharge and land-use effects on water quality

Issue

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

Action

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

Impact

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

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Site-specific nematicides improve profitability and lower environmental impact

Issue

Profit margins for cotton have declined significantly in the face of increased fertilizer and fuel costs. A significant constraint to profitability in the state is yield suppression due to root-knot and reniform nematodes that are widespread in the cotton production areas of the state. The estimated monetary loss to Arkansas cotton farmers last year was slightly over $300 million, and a conservative estimate based on results of grower-submitted nematode assays indicate about 40% of the state's cotton acreage is infested with one or both of these nematodes. No commercially acceptable nematode-resistant cotton cultivars are available and growers have historically relied heavily on annual applications of chemical nematicides that range in cost from $25-$45 per acre annually. Given the narrow profit margins for the crop, yield protection due to nematode control must be balanced against cost of nematicide application.

Action

In 2007, we introduced the concept of site-specific nematicide placement (SNP) within fields as a result of research conducted cooperatively since 2001 in Arkansas, Louisiana, Missouri, and South Carolina. This year, we provided educational/training opportunities to growers in northeastern and southern Arkansas, and assisted several growers in adopting the SNP approach on their farms. Growers were able to save from 30-50% of the cost of field-wide nematicide applications while maintaining the level of productivity within fields that had historically been achieved through whole-field treatment. This approach improved profitability considerably while providing a more environmentally appropriate alternative to whole-field nematicide application.

Impact

The SNP system significantly improved the profitability and lowered the environmental impact of nematicide use in cotton in the state. While the actual level of nematicide reduction on an individual farm and field basis will depend on the severity of the nematode problem, our estimates in Arkansas and Louisiana during the last two years indicate that at least 30% of the nematicide that is routinely applied is unnecessary. A conservative estimate in Arkansas alone would be a savings of about $3.1 million each year for our cotton producers. This approach has garnered both national and international attention, and I was asked to co-organize and speak at the symposium, "Precision Agriculture, Information Technology, and Nematode Control" at the 5th International Congress of Nematology in Brisbane, Australia, on July 17, 2008.

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Mineral crystals as a natural plant defense against insects

Issue

Damage by chewing insects can lead to serious losses in virtually every crop plant. Plants defend themselves against chewing insects with both pre-formed defenses and some defenses that are induced by insect damage. The formation of pre-formed mineral crystals in leaves might enhance natural levels of resistance to insects.

Action

An Arkansas research team is trying to understand how naturally formed calcium oxalate crystals in leaves of some plants are formed. Previous work by the team has shown that these crystals serve as an important part of defense against chewing insects. Recent findings are that the levels of calcium oxalate can be increased in soybean leaves by treating plants with calcium solutions. It remains to be determined if these changes lead to enhanced insect resistance. In addition, the team has initiated experiments to determine the effects of changes in calcium oxalate deposition on total gene expression. Researchers at the University of Arkansas Medical School are assisting in analysis of gene expression patterns.

Impact

In spite of intensive efforts to control pests, significant losses in agricultural production are caused by insects. We have recently shown that we can treat plants to cause a slight increase in the levels of defensive calcium oxalate. Our work with calcium oxalate crystals indicates that they are important in insect defense, and we might be able to utilize the genes responsible for this trait to produce plant varieties that are more resistant to herbivores. Understanding how these crystals are formed could lead to new strategies for selecting plants with altered levels, shapes, or localization of calcium oxalate crystals in crop species.

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Knapweed biological control: Redistribution of biological control agents

Issue

Spotted knapweed (*Centuarea* stoebe sp. *micranthos*, *Asteracae*) is an exotic weed that has aggressively invaded numerous habitats in northern Arkansas over the past 10 years. The weed displaces desirable forage and quickly dominates many habitats and makes invaded pastures less valuable, as cattle avoid feeding on the weed. Spotted knapweed is ecologically managed using biological control agents (insects that attack knapweed) in northern states. Only one of the 12 biological control agents established in North America occurs in Arkansas. This agent, a seed-feeding fly (*Urophora quadrifasciata*), was found to have more generations and destroy more seeds in Arkansas than in northern states. However, this knapweed natural enemy does not reduce seed populations or induce enough plant damage to decrease weed spread, at least partly due to the longer growing season in the south. Our ultimate goal is to implement a knapweed biological control program to reduce spotted knapweed populations in Arkansas.

Action

Based on our background work describing the impact of *U. quadrifasciata* in Arkansas and on experience in other regions of the country, we determined that two biological control agents–the flower head weevil (*Larinus minutus*) and the root weevil (*Cyphocleonus achates*)–hold great promise to suppress knapweed in Arkansas. During July, *Larinus* adults and immatures were redistributed to the Arkansas Ozarks, and a field nursery was established. Initial collections of overwintering larvae of *C. achates* in weed roots were made in Colorado in mid-October, to synchronize the development of this long-lived species with spotted knapweed grown in a warmer climate. We expect these insects to begin emergence in June, 2009. Establishment of both species is being tracked, and the impact on local and regional knapweed populations will be evaluated using traditional plant stand counts, photographic evidence, and GIS tools at the landscape level.

Impact

Redistribution of biological control agents is advised because the fly *Urophora quadrifasciata* alone does not provide a level of knapweed suppression necessary to reduce weed populations in infested areas, or to stop the weed's spread in the southern U.S. Redistribution of the two weevils into Arkansas provides the best potential to provide a level of biological control so as to reduce herbicides used against this weed while minimizing unnecessary movement of other species. Field nurseries proved the best opportunity to establish these biological control agents. Tools that are developed to track the impact of these agents on knapweed populations at the local and regional levels will also be useful in other weed biological control programs.

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Arkansas growers produce record yields growing blast-susceptible rice varieties

Issue

Historically, unpredictable blast disease frequently devastates rice in U.S. rice production areas with total yield loss observed in very susceptible varieties. Rice blast is primarily controlled using resistant varieties, cultural practices, and fungicides. The most obvious and widely recognized form of variety resistance occurs when one or more major resistance genes (R-genes) confer immunity to the blast disease. Unfortunately, R-gene varieties are often quickly overwhelmed by new and/or unexpected variants of the rice blast pathogen, *Magnaporthe grisea*. In contrast, a more sustainable rice blast field-resistance is available through the combined action of multiple major/minor resistance genes. Field resistance allows the plant to become diseased and is adversely impacted by field conditions. When rice blast is controlled, modern susceptible varieties typically out-yield R-gene-resistant varieties by 5 to 10%. Growers can alter various cultural practices to lessen the occurrence and impact of diseases. Fungicides are often not efficacious, and are expensive and difficult to utilize.

Action

Arkansas rice growers and scientists long observed extensive blast damage in plants growing under dryland conditions, such as on the tops of levees and in higher areas of a field with inadequate soil moisture, while nearby plants growing in the flooded parts of the paddy were healthy.

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. Cooperative Extension, using research results, showed growers how to use flood depth to minimize rice blast in the state. This has reduced the need for Arkansas farmers to use highly resistant but lower yielding varieties and allowed them to grow higher-yielding rice varieties that vary in blast susceptibility. Today, about 80% of the state acreage is planted to blast-susceptible rice vari-

eties, including 'Wells' and 'Francis', with little or no use of fungicides. In addition, the water management techniques aid breeder development of varieties and germplasm with increased blast field-resistance.

Continued research identified root-zone dissolved oxygen (DO) as the mediating variable for blast field-resistance mechanisms. DO content defines availability of plant nutrients and root production of hormones, primarily ethylene, which determine susceptibility to rice blast. 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 available in Arkansas and other rice-producing states. Research scientists manipulated this knowledge to prevent or greatly reduce the incidence of rice blast in Arkansas while selecting varieties with even higher levels of field resistance.

Proper irrigation procedures are the primary blast control strategy utilized by Arkansas growers and are now accepted by rice research scientists in the U.S. as an efficacious blast control methodology. When grown blast disease free, the susceptible cultivars yield 5 to 30 more bushels of rice per acre than available R gene-resistant varieties. At an estimated value of $5 per bushel, this additional yield provides approximately $25 to $150 of increased per-acre income in over 80 percent of Arkansas rice acres. A production cost reduction of $35 to $70 per acre is realized from reduced fungicide use, which in turn lowers the pesticide load on the environment.

During blast conducive years 2001-2008, Arkansas rice growers used flood management and other cultural practices to produce record or near-record per acre and statewide rough rice yields while growing very high-yielding, blast susceptible varieties. 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 race IE-1k blast, the disease does not occur in these varieties when growing in flooded conditions.

Impact

Grower acceptance of recommended fertility, irrigation, and disease scouting practices based upon these scientific concepts and research results have reduced disease incidence and severity. In addition, long-term benefits will accrue as plant breeders utilize the research to develop even higher yielding field resistant varieties.

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Funding:
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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 rice and related *Oryza* spp. in an effort to identify and define new disease-resistance genes. Existing and novel desirable genes are utilized by plant breeders to develop improved varieties. Rice pathologists define existing resistance genes and discover novel resistance genes, and provide research data about the optimal cultural practices necessary for disease control in susceptible varieties and to extend the 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 produced record rough rice yields in 2008 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:
Division of Agriculture, University of Arkansas System; Arkansas Rice Research and Promotion Board

Energy efficiency in poultry production

Issue

Poultry production and processing is a leading industry in Arkansas. Energy plays a significant role in the overall cost of operating a poultry production facility. Energy costs, including electricity and fuel, comprise more than 50% of the cash expenses of the growers. As a result of rising fuel prices and electricity rates, the cost of poultry production has significantly increased in recent years. A pressing need exists to help poultry growers reduce energy inputs and improve production efficiency.

Action

A comprehensive evaluation of energy use in relation to the building characteristics, energy intensive equipment, i.e. exhaust fans, lighting, and heating systems, etc., has been conducted using 17 years of data collected from the Applied Broiler Research Farm. Energy efficiency measures in broiler houses have been identified that could lead to electric and fuel savings and gains of productivity benefits to farm operations. Educational programs for poultry growers have been conducted including workshops, symposia, and farm visits.

Impact

As a result of the research and educational efforts, poultry producers are adopting cost-effective energy saving strategies, i.e., changing incandescent lighting to fluorescent lighting, choosing energy efficient exhaust fans at farm renovation, etc. Switching to energy efficient lighting is identified as the most cost-effective means of saving energy in production facilities with one year payback. Implementing this change on a typical four-house broiler farm is estimated to result in 17,000 kWh annual savings of electricity. The baseline energy consumption information can also assist local poultry growers in adopting alternative energy sources to lower production costs.

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Vegetative shelterbelts and windbreak walls to mitigate dust and odor emissions downwind from poultry farms

Issue

Air quality from concentrated animal feeding operations is an emerging issue that will affect the economic viability of animal agriculture in the U.S. As a number-two poultry state and home to several poultry integrators, Arkansas could be seriously impacted by the evolving air quality issues if not adequately addressed. Strategically planted vegetative shelterbelts downwind of the exhaust fans on commercial poultry farms could physically trap and disperse ammonia, dust, and odor emissions. It is also seen as an environmental friendly way to demonstrate a producer's commitment to being a good neighbor and environmental steward. Vegetative environmental buffers (or shelterbelts) strategically planted around poultry houses are natural air-filtering structures that reduce dust and gaseous emissions. They also provide certain dilution effects to odor plumes by creating zones of ground-level mechanical turbulence.

Action

In December 2007, a vegetative shelterbelt was established near the tunnel ventilation fans on the south side of a broiler house at Applied Broiler Research Farm. This shelterbelt consists of multi-row shelterbelts (45 trees total) including Crapemyrtle, Green Giant Arborvitae, and Japanese Cedar, covering a 40- x 110-ft area. This establishment is expected to reduce dust and gaseous emissions from the group of four tunnel exhaust fans by creating zones of ground level mechanical turbulence. The location selection also allows an increase of fan efficiency during prevailing summer wind activity. Properly designed windbreaks consisting of tarpaulin material fastened to frames near exhaust fans will be installed at one chicken house on the same farm.

Impact

Monitoring of particulate matter and ammonia emissions downwind of the tunnel ventilation fans is scheduled to be conducted in summer 2009 and 2010 to evaluate the fans' efficacy as a mitigation technology. Guidelines and recommendation of design and maintenance for vegetations and structural windbreak have been developed to assist local livestock producers in adopting these affordable, cost-effective technologies.

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Funding
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Impacts of repeated application of poultry litter in pastures are less than in pine plantations

Issue

Application of poultry litter to loblolly pine plantations has been found to increase tree growth and productivity. Recent studies by the Division of Agriculture have also indicated that single applications of poultry litter to loblolly pine

plantations have less of an impact on water quality than do applications to pastures. However, there is little information concerning the effect on soils and water quality of repeated applications of poultry litter to pine plantations.

Action

Scientists from the Arkansas Forest Resources Center and the Louisiana State AgCenter summarized results from three long-term studies that monitored phosphorus and nitrogen in soils from loblolly pine stands that received repeated applications of poultry litter for 3-5 years. The studies were located in the Upper Gulf Coastal region of Louisiana and Arkansas. Soil phosphorus accumulations, mineral nitrogen concentrations, and nitrogen mineralization were determined in both loblolly pine forests and pastures. The inclusion of all three studies by the scientists provided a more in-depth analysis of the issue than any one study by itself.

Impact

Annual applications of poultry litter resulted in the accumulation of phosphorus and nitrogen in the surface soils. Accumulation increased with application rates and frequency. Although initial phosphorus and nitrogen levels were lower in the loblolly pine stands than the pastures, increases of these nutrients in the soils were faster and greater in the forests than the pastures. These results indicate that although loblolly pine plantations can be a viable alternative to pastures for poultry litter application, litter application rate and frequency as well as differences in nutrient cycling dynamics between these two land uses are important considerations for environmentally sound application of poultry litter to pine plantations.

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Monitoring bollworm populations for susceptibility to Bt toxins

Issue

The Environmental Protection Agency requires annual monitoring for resistance in insect pests targeted for control by transgenic crops expressing toxins derived from *Bacillus thuringiensis* (Bt crops). The University of Arkansas System's Division of Agriculture has been involved in the establishment of baseline levels of susceptibility for insect response to these Bt toxins since 2002. Beginning in 2006, Arkansas was also designated the lead laboratory for annual monitoring of bollworm, *Helicoverpa zea*, populations. Activities in 2008 were expanded to include the Cry1F and Vip3A proteins expressed in Widestrike and VipCot cottons, as well as continuing to monitor field populations for susceptibility to the Cry1Ac and Cry2Ab2 proteins expressed in Bollgard and Bollgard II cottons.

Action

First-generation progeny of bollworm populations from 20 field collections across the southern U.S. and a few additional Arkansas populations were exposed to Cry1Ac, Cry2Ab2, Cry1F and Vip3A toxins in diet incorporation or diet overlay assays. A subset of these populations and laboratory susceptible and Cry1Ac-selected strains were also exposed to cotton plant tissues from conventional, Bollgard, Bollgard II, and Widestrike cottons to measure larval survival to pupation.

Impact

Results of diet assays indicated that levels of susceptibility were similar to those observed in 2007 with some slight increased variability among populations exposed to Cry2Ab2 and Cry1F. While this increased variability is important to recognize, the overall conclusion of the study was that the insect populations monitored are still susceptible to the Bt toxins expressed in Bt cottons. Paired observations between the laboratory assays and the cotton plant tissue studies provide important insight into the importance of variability in laboratory studies. A few bollworms survived to pupation when fed only Bt cottons. Survival was generally less than 5%; but since it was measurable, additional studies will help us define the importance of variability observed in laboratory assays.

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Funding
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Adaptive management of the statewide nonpoint source pollution plan for Arkansas

Issue

Section 319 of the Clean Water Act requires that each state:

- Assess the waters of the state for impacts from nonpoint source pollution,
- Develop a management program outlining how the State intends to address the categorical sources of pollution and the impaired waters identified in the assessment; and
- Report annually to the Environmental Protection agency progress made in implementation of the program.

Arkansas's management program expired at the end of

2004. New state and federal regulations along with ever changing environmental conditions in the state make it necessary to develop a major update of the current management program.

Action

The Division of Agriculture's Ecological Engineering Group developed an updated State Management Plan for 2005 through 2010, and used stakeholder-driven adaptive management strategies to revise and update the plan for 2008. The plan was approved in October 2006; it considers the impact of new regulations regarding urban and agricultural runoff, updated water quality information, and improved management measures developed over the last decade. The EEG used the Soil and Water Assessment Tool (SWAT) and ArcView GIS to model impaired watersheds in the state and to target specific nonpoint source problem areas. An extensive consensus building effort was conducted including facilitated meetings with all state and federal resource management agencies, local watershed action teams, agricultural commodity groups and other non-government organizations. The results of the modeling and consensus building will be compiled into a single document that will be submitted by the Governor to the EPA on behalf of the state of Arkansas.

Impact

The Nonpoint Source Management Plan establishes priorities for implementation of the section 319(H) Grant program and gives guidance to all state and federal agencies in development of their environmental protection actions. In 2004, the section 319(h) program alone expended over 6 million dollars on nonpoint source management. The consensus building program being conducted as an element of this project has brought together over 60 individuals representing 51 different agencies, NGOs, or watershed teams to discuss workable management actions concerning categorical and watershed-based programs. These management measures will be implemented in the state over the next five years.

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Funding

U.S. Environmental Protection Agency; Arkansas Soil and Water Conservation Commission; Division of Agriculture, University of Arkansas System

Monitoring of rivers for pesticides used in rice production

Issue

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

Action

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

Impact

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

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

Development and implementation of IPM programs for insects on Arkansas vegetables

Issue

Of the more important commercially produced vegetables in Arkansas, snap bean, squash, egg plant, spinach, greens, and cowpea are severely affected by insects. Previously, management of these insect pests was mostly based on chemical insecticide applications delivered when plants reached specific developmental stages. Snap beans were sprayed at first bloom and every week thereafter;

spinach received an insecticide application when plants were in the 2-inch rosette; and cowpea seedlings were sometimes sprayed when damage appeared, regardless of presence of insects. Although insecticides were repeatedly applied to squash for squash bug management, little control was obtained. Little to no effort at scouting for insects was made in Arkansas vegetable crops. As a result, insecticides were sometimes applied when no insects were present or when the least susceptible insect stages were present. This insect management approach was costly in several regards, including costs of chemicals ($5 to $10 per acre) and application ($3 to $5 per acre). Multiple applications per season increased these costs further. Additional problems associated with this management 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 have demonstrated the effectiveness of new insecticide seed treatments on greens, cowpea, and spinach. Application of acephate or imidacloprid to cowpea seed has the potential to reduce grower costs and provide excellent insect management. Studies have been conducted during recent years that document the biology and dynamics of the tobacco thrips on seedling cowpea. These studies have shown that thrips do not significantly reduce cowpea yield. Sampling techniques and thresholds have been developed and are currently in use in western Arkansas, northeast Oklahoma, and southwest Missouri for corn earworm larvae. 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 (Iowa strain) in traps (*Helicoverpa* pheromone traps). These combined insect monitoring strategies are now used in decision making for insecticide application in all snap beans produced in the three-state area.

Impact

Alternatives to foliar insecticide sprays for aphid management on spinach are now available and 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. When snap bean personnel have followed these practices, insecticide use has been reduced by about 40% with no reduction in snap bean quality. Additional benefits include reduced exposure to insecticides during application by producers and pilots and reduced environmental hazards. Squash and pumpkin producers now have a method of managing squash bug.

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

Corn and cotton response to high organic-matter alternative fertilizers in Arkansas

Issue

Cotton and corn yield in Arkansas is usually increased by nitrogen (N) fertilization. Record high synthetic fertilizer prices coupled with desire for improving soil quality have rekindled interest in utilizing high organic matter byproducts as alternative fertilizers. Fresh poultry litter (FPL), pelleted poultry litter (PPL), and biosolids are three alternative fertilizers available to Arkansas producers. Unfortunately, there is very little information on crop response to biosolids, FPL, or PPL in Arkansas.

Action

A field experiment was conducted to evaluate the effect of four N sources (FPL, PPL, biosolids and urea) each applied at 0-300 lb total N/acre (at 60 lb total N/acre increments) on corn. Another field experiment was conducted to evaluate the effect of the same N sources each applied at 0-150 lb total N/acre (at 30 lb total N/acre increments) on cotton.

Impact

Nitrogen application rate significantly increased both seedcotton yield and corn grain yield compared to the No N (control). All N sources significantly increased corn or cotton yield. Averaged across N sources, corn yields increased significantly as N rate increased and ranged from 89-217 bu/acre. Averaged across all N rates, corn grain yield was greatest for corn fertilized with urea and slightly lower for corn fertilized with FPL, PPL, or TCO, which all produced similar corn yields.

Averaged across all N sources, seedcotton yield ranged from 1228 to 3279 lb/acre and increased significantly with increasing N-rate. When averaged across all N sources, urea produced highest yield followed by biosolids followed by FPL and PPL.

These results suggest that FPL, PPL, and TCO can be used to supply some of the N requirement of a growing cotton or corn crop. However, these organic-based alternative fertilizers should be combined with inorganic N sources to sustain maximum crop yield and reduce potential water quality risks.

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Funding
MANNCO Fertilizer Company; Division of Agriculture, University of Arkansas System

Identifying best management practices that reduce pollution and risk

Issue

Agriculture is a primary stimulus of economic growth in the Arkansas Delta. However, large acreages of rice and soybean employ high levels of fertilizers, pesticides and water for production. Without proper management, use of these inputs could lead to sediment and nutrient movement off the farm and into nearby rivers and streams, further exacerbating water quality issues that already exist in the region.

Action

A stochastic simulation model of a combination of 54 best management practices (BMPs) scenarios including two levels of tillage, three fertilization rates, and three filter-strip widths was used to address total phosphorous (TP) loading in the L'Anguille Watershed in Arkansas. The purpose of this study was to identify the efficient set of BMPs in terms of its effectiveness to reduce TP and its relative costs to rice and soybean producers. Scenarios were ranked in terms of their relative cost effectiveness of reducing TP per dollar spent using stochastic efficiency techniques under a wide range of risk aversion levels. Results suggested that five BMP combinations consistently outrank all others, regardless of sub-basin size or amount of land devoted to agriculture in the sub-basin. Scenario 10 (rice conservation-till, soybeans no-till, low level of phosphorous (P) fertilization for both crops and a filter strip of 5 meters wide for soybeans) was the most preferred regardless of the decision maker's risk preferences.

Impact

The economy of the Arkansas Delta region relies greatly upon production of row crops. Few studies have analyzed crop revenue risk in the state of Arkansas but no one has specifically addressed the issue of cost-risk incurred by producers when implementing BMP practices as a possible solution to water degradation. However, it is important to highlight that the effectiveness of BMPs should be rated not only in terms of their impact on pollutant loads but also by their acceptability to producers. Considering this last point, this study aims to enhance the body of water conservation literature by evaluating the risk faced by crop producers when they need to deal with the joint effects of water regulations and the cost of implementing BMPs in their farm operations.

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Biodrying of animal manure as a pretreatment for thermochemical conversion processes

Issue

Moisture content of fresh manure of beef, swine, and poultry are 85, 87, and 74% (weight), respectively. Due to the high moisture content, it is not economical to transport raw manure over long distances. Handling these wastes in compliance with stricter environmental regulations can have a significant economic impact on livestock production. The objective of this study is to evaluate the biodrying performance of beef, swine, and poultry manure-corn stalk mixtures as a pretreatment for thermochemical conversion process.

Action

Negative aeration was applied to biodrying reactors in downdraft mode. Thermophilic temperature levels, of about 60°C, were achieved after 19 days for the beef manure, 4 days for swine manure, and 3 days for poultry manure. Manure moisture content reduced to less than 30% within two to three weeks for manure types investigated.

Impact

The results of this study confirm that the biodrying technique is a valid method of reducing manure moisture content from the range of 60% to the range of 30% and producing a product suitable for gasification technology. Farmers and livestock producers might gain two-fold benefits including reduction of waste transportation cost and production of bioenergy.

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Biological phosphorus retention in tributaries of the Illinois River, Arkansas

Issue

The Illinois River in Arkansas and Oklahoma may have experienced elevated nutrient levels over the last two decades. Although remediation efforts have begun, the time required for ecosystem recovery is unclear. One reason is that phosphorus (P) stored in the tributaries may begin to "leak" out of these systems as P loading from the watershed decreases. The length of time required for P from the tributary microbial communities to reach equilibrium with P in overlying water is unknown.

Action

Two separate studies are underway to assess the role of

biological P storage by microbial communities in tributaries of the Illinois River. One study is exploring differences in periphyton biomass and elemental composition in streams draining watersheds with diverse land cover including forest, agriculture, and urban areas. The goal of this study is to assess whether differences exist within streams due to variation in rock substrate size and among streams due to land cover. Another study explores the effect of light, temperature, and elemental composition dependence of P uptake by periphyton. Although the effect of light and temperature variation on periphyton P uptake has been evaluated in other stream systems, to our knowledge the influence of these factors has not been tested in conjunction with constraints by elemental composition. We hypothesize that periphyton in streams experiencing historically high P concentrations will have periphyton communities with relatively low C:P ratios, while periphyton in streams experiencing historically low P concentrations will have periphyton communities with relatively high C:P. Further, we hypothesize that light-dependent P uptake rates will decrease with decreasing periphyton C:P.

Impact

Both studies are currently in progress. Experiments were conducted in October 2008 and January 2009 and will be repeated in spring and summer 2009 using periphyton taken from streams during those times. Results of the studies will allow us to model the dynamic nature of P cycling by microbiota in Illinois River tributaries and estimate the length of time required for water quality improvements to be apparent at the ecosystem scale.

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

Issue

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

Action

A University of Arkansas System Division of Agriculture molecular biologist performed molecular and genetic characterization of an epigenetic mutant of *Arabidopsis* phytochrome A gene.

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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Division of Agriculture, University of Arkansas System; Arkansas Biosciences Institute; USDA/ CSREES/ Biotechnology Risk Assessment

Development of alternative methods to manage the lesser mealworm in poultry production facilities

Issue

The lesser mealworm, *Alphitobius diaperinus* (Panzer) (Coleoptera: Tenebrionidae) is a small (5-6 mm), shiny, black beetle species with a cosmopolitan distribution. As poultry production moved to indoor housing beginning in the early 1950s the "litter beetle" has become an abundant, serious pest in poultry operations. Adults and larvae feed on spilled grain, feces, and sick/dead birds. In addition, the larvae burrow into and cause serious damage to the insulation in poultry houses while seeking a secluded site for pupation. Most importantly the beetles are known to harbor a number of pathogens that cause both avian and human diseases. These pathogens are transmitted because both chickens and turkeys consume the adult and larval beetles.

Action

The possibility that aggregation pheromones are secreted by the male and or female beetles was determined by data that indicated that beetles were consistently "clumped" in specific areas while few beetles were collected in other areas. In collaboration with researchers in the USDA-ARS Crop BioProtection Research Unit, we have determined that volatiles are emitted from the beetles. We also have identified five pheromones secreted from male beetles, one of which has also been identified from female beetles. Four male-specific compounds have been characterized: (R)-(+)-limonene, (E)-β-ocimene, (S)-(+)-linalool, sesquiterpene, (R)-(+)-daucene and 2-nonanone (also identified in small amounts from female beetles). In pitfall bioassays, we found that male-derived volatiles containing these compounds were more attractive than the corresponding female-derived samples lacking the compounds. Field testing in commercial broiler production facilities has shown that significantly more lesser-mealworm adults were collected in traps containing pheromones compared to traps containing no pheromones. Additional field tests utilizing the pheromones will be conducted in the spring of 2009 to understand the dispersal of adult and larval beetles after litter from the poultry facilities has been spread over pastures.

Impact

The pheromones from the male beetles will be used to attract the beetles to traps where they can be killed. The use of these traps will reduce the dependence on repeated insecticide treatments of entire facilities. Reductions in beetle numbers will reduce pathogen spread within the facility and other facilities where the beetles move during litter removal. In addition, fewer adult beetles will produce fewer larvae, thereby reducing the insulation damage caused during pupation.

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Control of varroa mites–the number one pest of honey bees–with botanical smokes

Issue

The honey bee is the most valuable insect in United States and world agriculture. Without its pollination services, many crops would be impossible to grow. Its value for pollination of apple, almond, strawberry, melons, and many other crops is valued at more than $15 billion per year in the United States alone. It is also important for honey, beeswax, and other products. Unfortunately the honey bee is seriously threatened by many pests and diseases. The most important pest of honey bees worldwide is the Varroa mite. This mite has developed resistance to the chemicals used to control it and alternative methods of control are needed.

Action

There have been many anecdotal accounts and reports in the bee literature of the effect of smokes from various botanical sources on knocking Varroa mites off honey bees. We tested a number of botanical materials that had been claimed to be efficacious for mite control–including grapefruit leaves, sassafras root, pixoy seed pods, sumac seedheads, and an experimental botanical mixture–and compared them to pine needles and no smoke for their effect on Varroa mite knockdown in commercial and hobbyist bee hives. Our tests indicated that most of the botanical materials that had been claimed to be efficacious in anecdotal accounts and literature were not of practical benefit. However, an experimental botanical mixture we developed and tested did appear to knock Varroa mites off honey bees, and a patent may be pursued.

Impact

The efficacy of home remedies, such as botanical smokes, for Varroa mite control by beekeepers needs to be assessed in controlled replicated studies for their true efficacy. This is important so that beekeepers do not waste time on ineffective controls. We found that most anecdotal claims for the efficacy of botanical smokes did not hold up. This information helps beekeepers worldwide. However, our experimental botanical mixture used in smokers did reduce mite numbers and further testing will show just how much promise this material has for mite control. If it holds up, it will be a useful control method for these serious pests of honey bees.

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Natural enemies of the tarnished plant bug, *Lygus lineolaris*, in Arkansas

Issue

The tarnished plant bug, *Lygus lineolaris*, is a major pest, attacks many important crops, such as strawberries, peaches, various vegetables, and in Arkansas, it is a key pest of cotton. It is an expensive and difficult pest to control and alternative approaches to chemicals are needed due to the development of resistance. Little is known about the natural enemies of tarnished plant bugs in Arkansas. Therefore, we undertook a study of the parasitoids and pathogens present in Arkansas populations of this pest.

Action

Live tarnished plant bugs were captured weekly from three natural tallgrass prairie sites and three agricultural sites in Arkansas. The bugs were kept alive in individual cages to allow for the development of parasitoids or pathogens. Out of a total of 3405 *L. lineolaris* collected from both sites, 1.8% were parasitized by braconids, 0.09% by tachinids, 0.5% by mermithids, and 2% by fungal pathogens. Of note, the entomophthoralean fungus, *Pandora heteropteris*, was found infecting three *L. lineolaris*. *Pandora heteropteris* has been only reported once previously, from a single, unidentified hemipteran nymph in Poland.

Impact

This study shows that, in general, natural enemies of tarnished plant bugs do not have a major impact in Arkansas. However, one goal of this research was to discover novel microorganisms that could have use in biological control of tarnished plant bugs. Exploratory research is necessary to find the organisms that can be studied for their potential utility in the future. In this case, the novel fungus, *Pandora heteropteris*, has never been found in North America before and nothing is known about its potential as a biological control agent for tarnished plant bugs. Therefore, further studies will be conducted on its effects on this pest. The first step in development of new control agents for pests is the discovery of such agents.

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Impact of using 'Phaucet' computer program for furrow irrigation design

Issue

Ground water for irrigation is becoming less available in some areas of the Arkansas Delta and the cost of pumping the water is a significant part of crop production. Growers need help with irrigation water management options that can increase irrigation efficiency and conserve water while decreasing irrigation pumping cost. The 'Phaucet' Computer Program (PCP) was developed by a Missouri Natural Resource Conservation Service (NRCS) team to assist with the design of furrow irrigation systems.

Action

The PCP was used by University of Arkansas System's Division of Agriculture staff to help a grower improve water management on furrow irrigated fields. He was first assisted with determining the pumping capacity of several of his irrigation wells with a flow meter that was provided for his use. The PCP was provided to the grower and he was trained on how to use it for designing the furrow irrigation for six early planted corn fields. The grower was asked to keep up with the pumping time required for the fields so a comparison could be made to the pumping time required in previous years. He was so impressed with how the PCP improved the irrigation on the six fields that he started using it to design several of his other fields. By the time the 2008 season was over, he had used the PCP on 155 different fields that involved 4300 acres of corn, cotton, and soybeans that were irrigated with 42 different irrigation wells.

Impact

The grower indicated that in comparison to previous years, he reduced the irrigation pumping time on the fields by an average of 25% and that the savings was almost 50% on a few of the fields. He also commented that this caused the $4 per gallon diesel cost to become $3 per gallon, which resulted in a pumping cost savings of $100,000. This savings was due to an increased irrigation efficiency associated with a significant reduction in the amount of water runoff from the fields. The reduced pumping time resulted in saving just over 665 million gallons of ground water from having to be pumped from the irrigation wells. To put this in perspective, the water saved is equivalent to 5.7 inches of water covering all of the 4300 acres. The reduction in the amount of water runoff from the fields not only increased the irrigation efficiency but it was also very beneficial in protecting the environment. A much greater impact is expected when this is expanded to more growers through the efforts of University of Arkansas Division of Agriculture staff. This effort will hopefully result in similar results on a large percentage of the almost 2 million acres that are furrow irrigated in Arkansas.

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Discovering the ants of disturbed forests to better understand long-term consequences on their communities

Issue

The nature of change in forests of the South has accelerated as the demand for wood products increases. Conversions of forests to pine plantations, and cutting within plantations, are intensifying to meet these demands. This means there is an increasing area of plantations, which may foretell long-term changes in plant biodiversity, and, with it, animal biodiversity. These plantations may also become more vulnerable to pests in the future. Given these changes, little information is available for the southern U.S. on how insects are affected by forestry activities such as harvesting or thinning, or how insect communities recover from such activities. Studies are underway in southeastern Arkansas that investigate the ant communities that live in forested landscapes influenced by cutting 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 cutting 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 cutting practices in forests have on ants will be assessed by relating species assemblages based on pit-fall sampling of ants over many years to the plant and other environmental factors measured at study sites. Some studies at individual sites have been ongoing for more than 18 years.

Impact

Residual effects on the ant community of two harvesting treatments (clearcut and selection cut) done 12 years earlier in pine-hardwood forests showed that 18 of 51 species collected (38%) were almost ubiquitous and dominated the site, comprising 93% of the community abundance. Most of

these common species were found in all treatments, but six were more abundant in the undisturbed check stands. However, one species showed more abundance in selection harvests, and two others for the disturbed clearcuts and selection cuts. The ant community in the undisturbed checks was found to be numerically different from those in the disturbed treatments 18 years after disturbance. Thus, nine members of the ant community remained sensitive to these old harvesting disturbances. We suspect that the species that are more plentiful in the undisturbed checks are there because of the hardwood component, which was missing from many of the treated stands dominated by pines. This study shows that some ant species remain sensitive to old harvesting treatments. However, the study also showed that the ant community in the disturbed stands is looking more like that in the undisturbed checks as time goes by. Perhaps they will be similar sometime in the near future as plant composition continues to change in the disturbed treatments.

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Division of Agriculture, University of Arkansas System; Arkansas Forest Resources Center, Monticello

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

Issue

Robber flies comprise one of the most diverse, abundant, and conspicuous families of flies. Over one thousand species are known to occur in North America. Adult robber flies are opportunistic, aerial predators of many kinds of insects, whereas the larvae are predators, ectoparasites, or parasitoids, feeding on eggs, larvae, or pupae of other insects. Most successfully-reared species have been shown to feed on white grubs (Coleoptera: Scarabaeidae). Over the past half century, the scientific community has become increasingly interested in these flies as indicators of environmental health –because of their restricted ecological requirements–and as potential biological control agents. Additional studies will help fill in missing information about these important insects.

Action

Before the present survey was started, only 42 species of robber flies from Arkansas were recorded in the published literature. Recent collection and analysis have resulted in a checklist of 131 species. It includes 101 species studied by the authors, of which 66 species were recorded for the first time from the state. Seven more species have been recorded in the literature, and 23 species that might occur in the state have never been recorded. The Arkansas robber fly fauna has close affinities with the fauna of the eastern United States. Some Arkansas specimens previously considered *Efferia nemoralis* have been reclassified as *Efferia plena*.

Several robber fly species are rare in Arkansas, and they may deserve to be classified as species of special concern for conservation purposes. Work has been completed on a taxonomic revision of the poorly known genus *Ceraturgus* in North America, all species of which are rare throughout their ranges. Research led to descriptions of rare new species, known only from the endangered blackland-prairie habitat of Hempstead Co., Ark. In addition, work was completed on descriptions of North American robber fly pupal cases.

Impact

Along with butterflies, tiger beetles, and dragonflies, robber flies are receiving increased levels of interest as a focus of conservation concern. Concern that destruction of specialized habitats has contributed to population declines among some species of robber flies has grown in recent years.

Many remnant prairie areas, dotted across the state, are now protected by the Arkansas system of natural areas. Nine recorded and probable Arkansas species seem to be associated with prairie regions of the South Central United States. Four more species also occur in more northern and eastern prairie states. These elements may be of interest in the management of Arkansas' remnant prairies. Forest species may be adversely affected by logging operations, especially those that remove woody debris used as breeding sites by larvae.

Conservation and biological control work cannot proceed in the absence of a modern review of the state's robber fly species. This project will summarize all that is known about the robber flies occurring in Arkansas and set the stage for further research of economic and conservation concern.

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Ozark subterranean insect diversity and protection of groundwater resources

Issue

Subterranean ecosystems harbor a rich diversity of life that is critically imperiled and poorly documented. The goals of the Arkansas Subterranean Biodiversity Project are to discover and protect the diversity of life underground, to investigate ecosystem processes of subterranean habitats, and to preserve cave and groundwater resources for future generations. Project cooperators inventory underground and aquatic habitats and karst features, survey caves and define recharge basins, monitor environmental quality, monitor cave populations, and create educational outreach tools and programs.

Ground water supplies 62% of the overall water demands of the United States, yet little is know about groundwater ecosystems. Groundwater habitats provide crucial ecological services and sustain rich endemic communities, 90% of which remain undescribed. Despite the importance of subterranean habitats, they have received very little study by the scientific community. Less than 10% of an estimated 1000 troglobitic Ozark Plateau species have been described from this ecoregion. (Troglobites are obligate cave dwellers so completely adapted to caves that they are restricted to this environment.) Little is known about the distribution of species and their limiting factors. Very few food webs have been described, and nutrient dynamics are poorly understood.

Action

Many cave systems, several containing federally listed endangered species, are being investigated in this effort to

understand and preserve the underground biodiversity of the Ozarks. The University of Arkansas Arthropod Museum and its Curator are project cooperators, along with the Arkansas Natural Heritage Commission, Arkansas Soil and Water Conservation Commission, Arkansas Department of Environmental Quality, Nature Conservancy, U. S. Forest Service, U. S. Geological Survey, and U.S. Fish and Wildlife Service. The Arthropod Museum is a depository for insects and other arthropods collected by the Subterranean Biodiversity Project. The Curator identifies insects, especially Diptera and Coleoptera, collected during the course of the project.

Impact

Knowledge of subterranean ecosystem dynamics is needed not only for the protection of the groundwater resource, but because those species inhabiting subterranean habitats are among the world's rarest and most endangered freshwater fauna and are under-protected in the existing network of preserves. Results from this project will add to the state of knowledge and help to design protection plans for subterranean ecosystems.

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Funding

Arkansas Subterranean Biodiversity Project; Division of Agriculture, University of Arkansas System

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

Issue

Arthropods are the earth's most diverse organisms. Over 60% of all known organisms are arthropods (insects, spiders, mites, crustaceans, and related groups). Insects account for over half of all species described, and they are the dominant form of life in terrestrial environments. Approximately 35,000 to 40,000 species of arthropods have been recorded from Arkansas, and it is still not uncommon to find species here that are new and unnamed.

Pest arthropods cause harm to man and his structures, crops, and livestock whereas beneficial species pollinate crops, prey on pests, or serve as food for wildlife. In an environmentally conscious society, arthropods are regarded as essential components of our ecosystems. Knowing the name of an arthropod is the key to unlocking the store of accumulated knowledge about its life history, distribution, and relationships to man. Unfortunately, most arthropods are not easily identified to species level by the general student, or even by trained, professional entomologists. Even the most dedicated specialists find it difficult to identify some species they encounter.

Action

The University of Arkansas Arthropod Museum houses the largest research and reference collection of insects and other arthropods in the State of Arkansas. The museum is listed and described in the most recent compilation of world insect collections, and the worldwide insect systematics community uses the collection for taxonomic research purposes. Label data associated with specimens in the Museum record when and where species occur in the state. The Museum, located in the Ozark Plateau within a short distance of the Ouachita Highlands, maintains one of the few large collections of the insect faunas of these two areas, which are species-rich and with unique fauna yet are poorly surveyed. The Curator cares for the collection and makes annual efforts to increase the size and diversity of the collection so that it becomes ever more representative of the Arkansas fauna. Museum specimens in all groups of arthropods are identified using specialized techniques, equipment, and literature; the specimens are priceless reference resources for comparison with unknown specimens. An extensive literature collection is at hand to facilitate timely identification of pests, beneficial species, and other species of concern. The Curator provides identification and information services to extension personnel, researchers, and the general public. Specimens are loaned to researchers around the world. Auxiliary collections are maintained for demonstration and teaching purposes. A growing website is dedicated to assisting the Museum in its extension, research, and education missions.

In 2006, Museum staff started the process of rearranging genera and species alphabetically within family. The old phylogenetic classification systems are unstable, because of new classifications based on molecular techniques, requiring the change to be able to locate specimens of a given species. Staff also continued a long-term project in which alcohol-preserved specimens are being transferred to screw-cap vials with evaporation-resistant caps. The Peggy Rae Dorris spider collection, received as a donation from Henderson State College in 2005, has been sorted and most specimens have been placed in screw-cap vials with fresh alcohol. In 2008, five new popular articles authored by the Curator were added to the University of Arkansas Arthropod Note series on the Museum's website: snake-worms, No. 57; trapdoor spider, No. 58; luna moth, No. 59; Mydas fly, No. 60; and odd beetle, No. 61. The Curator also submitted two invited entries to the Encyclopedia of Arkansas History and Culture. The entry on the striped bark scorpion has been published online. The entry on Arkansas insects is being reviewed and edited.

Impact

With the aid of the specimens and associated literature collections, the Curator annually provides hundreds of reliable arthropod identifications and information services. These services assist researchers, government agencies, businesses, and individuals in their efforts to control insect pest problems and protect the environment. Each year, Museum specimens are displayed at various venues, giving upwards of 15,000 citizens some exposure to the world of insects. The Museum website
www.uark.edu/depts/entomolo/museum/museum.html

reaches out to researchers with a bibliography of Arkansas arthropod biodiversity, and it reaches out to extension specialists and the general public with a series of illustrated popular articles on important and interesting regional species. The Curator teaches a graduate-level course on insect diversity and taxonomy. Museum resources are essential to the success of these courses.

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Division of Agriculture, University of Arkansas System

Toward cellulosic-derived bio-fuels

Issue

Although there are roughly 150 corn-to-ethanol plants with a production capacity of 9 billion gallons, there is a need for additional bio-based liquid fuels. The next generation of bio-fuels centers on the transformation of cellulosic biomass to liquid fuels, such as ethanol or butanol. The objectives of this study are to determine conditions in which cellulosic biomass can be pretreated before being converted to bio-fuels. This pretreatment step includes the insertion of an extraction operation aimed at extracting valuable phytochemicals from the biomass prior to conversion.

Action

Producing biofuels in the saccharification platform implies the release of cellulose and hemicellulose from the biomass by pretreatment with dilute acid or hot water. To reduce production costs, it is imperative to economically convert both the hemicellulose and cellulose sugars to ethanol at high yield. Although the major emphasis has rightfully been placed on cellulose conversion in the past, hemicellulose depolymerization must also be thoroughly understood because hemicellulose represents 20-40% of the lignocellulosic biomass. However, hemicellulose depolymerization is not simple because its depolymerization during pretreatment forms a suite of uncharacterized oligomers, and undesirable degradation products, such as furfural. Through this research project, hemicelluloses-derived oligomers are produced, and their depolymerization is studied. This project is ongoing.

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Factors influencing borrower exits from the Farm Service Agency direct loan programs

Issue

The Farm Service Agency (FSA) makes direct operating loans, farm ownership, and emergency loans to family-size farmers and ranchers who cannot obtain commercial credit from a bank, cooperative Farm Credit System institution, or other lender due to gaps in the credit markets. FSA loans are often provided to targeted groups—socially disadvantaged farmers and beginning farmers. The FSA direct farm loan program is designed to provide credit to family-sized farms that cannot get credit from conventional sources at market rates and conditions despite having sufficient cash flow to repay and an ability to provide security to collateralize the loan. In administering the loans, FSA has a goal to minimize defaults and to hasten the time when borrowers can exit the direct loan program and move on to conventional credit sources. In essence, the direct loan programs are meant to be transitory and not a permanent source of credit for farm operators. This policy goal of moving borrowers from direct loans to conventional credit sources is reflected in the larger loan volume of the FSA guaranteed loan program in which FSA guarantees the loan principal up to 95 percent from a conventional lender. To better enhance the transition to conventional loan sources, analysis was undertaken to identify those factors that were key in motivating borrowers to exit the direct loan program.

Action

FSA farm loan managers (FLM) were surveyed in November and December of 2004 using a survey instrument designed by a team of University of Arkansas researchers. The FLMs went to borrower files to collect data on a systematic sample of loans made in fiscal years 1994–1996 in forty-eight states (excluding Hawaii and Alaska). There was a 90 percent response rate, which is excellent for this kind of survey. The survey was stratified so that there was good geographic, ethnic and loan type representation. In addition, data were collected directly from FSA on whether the borrowers originating loans in 1994-1996 were still participating in direct loans as of the end of November 2004. The data were collected by a secure, FSA intranet and then delivered to the University of Arkansas for cleaning and analysis. A multinomial logit was estimated with four possible outcomes: 1) borrower was still active in FSA direct loan programs, 2) borrower was still in farming using conventional credit sources or no credit, 3) borrower voluntarily left farming or 4) borrower left farming involuntarily (other than death). The variables influencing which of these outcomes was the most likely were demographic variables or loan type (operating, farm ownership, or emergency loan); whether the loan was in the socially disadvantaged or beginning farmer program; variables indicating number of existing

direct loans when the observed loan was originated; and various financial variables.

Impact

The data show that FSA direct loan borrowers do not simply pay back one loan and then originate another. Fifty-five percent of the unique borrowers in the survey had left the direct loan program by approximately nine years post-origination. Borrowers exited the FSA direct farm loan program for many reasons. Approximately 24% of the surveyed loans originated in fiscal years 1994–1996 and terminated by November 30, 2004 had borrowers who left farming voluntarily for reasons other than retirement. A little more than half of the loans had borrowers who left the FSA direct loan program and remained in farming. A relatively small group of farmers continued farming without any credit. Twelve percent of the loans were associated with borrowers who exited from farming involuntarily (other than death). The logit model implied that frequent direct loan borrowers were less likely to be among the exited borrowers suggesting FSA might consider limiting the number of loans to a given borrower over time. Borrower financial strength at origination was also found to be important. High debt-asset ratios and lower net worth led to difficulties as did financial difficulties prior to origination. The beginning farmer loans were associated with borrowers who subsequently left farming voluntarily at a higher rate than non beginning farmer loans. Socially disadvantaged loan borrowers were less likely to exit involuntarily. Borrowers with farm ownership loans were less likely to exit the loan program, perhaps suggesting that low interest rates associated with FO loans might encourage such behavior. The study reveals that the direct loan program furnishes transitional loans to financially marginal farmers. Most borrowers did not become long-term FSA clients. Increasing financial requirements might hasten the transition process but at the cost of excluding perhaps the most stressed borrowers.

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Understanding the readership of the *Angus Journal*® and the *Angus Beef Bulletin*®

Issue

Livestock and breed associations are constantly looking for ways to improve publications while expanding their readership base. Angus Production Incorporated (API) produces the *Angus Journal*® (*AJ*) and the *Angus Beef Bulletin*® (*ABB*) and is a subsidiary of the American Angus Association located in St. Joseph, Mo. These publications contain information pertaining to all aspects of the Angus cattle industry. Some examples of publication diversity include commercial breeders, seed stock breeders and finishers, registered Angus cow/calf operators, and junior show competitors. In an effort to improve these publications, studies were conducted to identify the needs and expectations of *AJ* and *ABB* audiences and determine revisions and improvements needed in the publications.

Action

This study was designed using descriptive survey methodologies. Two readership questionnaires were developed to assess readership, future direction, past purchasing of advertisements, and reader demographics of each publication. Online versions of the instruments were created to provide an alternative opportunity for instrument completion. There were 1,117 initial *AJ* respondents. Because of the low response rate, a random stratified sample of 2% (580 individuals) was contacted by follow-up phone calls to complete the instrument. This resulted in 167 additional responses for a total N of 1,284 (approximately 7.5%). Non-response error was controlled by comparing early and late respondents. There were approximately 500 instruments collected from *ABB* readers. The study identified publication adjustments the readers felt should be made to these publications, respectively. API's intentions are to use findings from this study to make adjustments to better meet the needs of its audiences. This data should improve the *AJ* and *ABB* publications and hopefully improve current subscription rates.

Impact

Readership instruments created by researchers at the University of Arkansas were placed in an issue of the *AJ*, which was sent to more than 17,000 subscribers, and an issue of the *ABB*, which was sent to nearly 78,000 readers. Through this study, API (the largest beef cattle breed association in the U.S.) will be able to more effectively and efficiently deal with their diverse readership bases and make efforts to improve their publications. Results of this study cannot be reported due to a confidentiality agreement. This study will also provide additional information on measurement in editorial research and assist with building a more comprehensive body of comparative research literature

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Angus Productions Inc.; Division of Agriculture, University of Arkansas System

Understanding woodcock (*Scolopax minor*) winter-habitat requirements 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. Current management plans have indicated a need to investigate characteristics of woodcock wintering habitat, as well as density estimates and factors contributing to declines.

Action

A project was initiated in the winter of 2008, and will continue for the next 2 years with the assistance of a graduate student beginning August 2009. The goal of this project is 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, determine density or estimate occupancy. Methods included establishing transects in replicate vegetation types (bottomland hardwood, upland hardwood, and pine) and sampling them with bird dogs. Researchers recorded the number and location of flushed woodcock and determined vegetation type and age class.

Impact

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

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U.S. and German culinary innovation processes: Differences in involvement and other factors

Issue

Management of the innovation process has been prescribed as an important component driving the likelihood of innovation success as well as a prescription for competitive advantage in today's business environment. While most models of the innovation process are based on product-driven tools, recent studies indicate that successful innovation processes in service, hospitality and culinary settings require substantive differences. Four research questions were derived to evaluate this issue: 1) What is the innovation process used by New York Michelin-starred chefs? 2) How does it differ from more traditional European settings? 3) How does the depth and breadth of involvement differ in these two settings? 4) What identifiable differences impact the Michelin evaluation system in the U.S.?

Action

This study considered the innovation process used by New York City Michelin-starred chefs and compared the process with Michelin-starred chefs in Germany. This unique setting provides a rare glimpse into the culinary innovation process in restaurants of the highest quality based on external evaluation. The study of the innovation process in a high-caliber, Michelin-starred setting provides a unique chef-restaurant dyad. This dyad setting provides an opportunity to consider breadth and depth of involvement simultaneously as well as qualitatively derived descriptions of contextual factors impacting the level and type of involvement used. For this study, semi-structured interviews with Michelin-starred chefs in New York and Germany were utilized to better understand the underlying factors and dimensions that describe process practices.

Impact

The analysis of the innovation process used by German and New York Michelin-starred restaurants provided examples of several similarities but also several differences. One of the key differences is the level of depth and breadth of involvement throughout the process. German Michelin restaurants appear to utilize an innovation process that had some breadth of involvement but very little depth of involvement. Breadth factors include involving key employees (utilizing their knowledge specificity), specialized suppliers/farmers, and external peers. Thus, the process can be described as moderate breadth of involvement and low depth of involvement. New York Michelin operations appear to utilize involvement approaches that have moderate to high levels of breadth (involving key employees throughout the process, tight relationships with suppliers/farmers, and high involvement of internal sous chefs) and greater depth of involvement in the concept development, testing, and commercialization stages.

Results indicate there is no single best way to manage the innovation process and the best way to manage innovation in a foodservice setting may depend on differences such as the size of the operations (New York restaurants were substantially larger than their German counterparts) and cultural and institutional differences. Thus, successful leaders in the foodservice industry are likely to interpret the complexity of their environment and involve others in organizational processes when it is necessary to create buy-in, make use of dispersed knowledge, or speed the process of implementation.

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21st Century Endowment in Hospitality; Division of Agriculture, University of Arkansas System

The impact of beer type, pizza spiciness, and gender on match perceptions

Issue

While one often thinks of food and wine when considering pairing possibilities, recent interest has been shown in the beer and food pairing arena. Recent articles in journals and the popular press point to opportunities for restaurateurs to use beer and food pairing as a method for increasing guest satisfaction and interest in this area. The topic is contentious in that most literature written about it is subjective in nature and lacks empirical or systematic testing. Therefore, a key purpose of this exploratory study was to determine which style of beer creates a perception of the best match when consumed with a spicy or non-spicy food. Specifically, we considered three beer categories (lager, ale, and stout) and the perceived level of match with a spicy and non-spicy pizza.

Action

This study utilized a tasting panel method to assess 'just right' match levels for pizza and beer. A 'just right' scale provides a graphic description that can also be described as deviation-from-match where participants rate the combination of food and drink for too little, too much or just right sensations of match in defined characteristics (e.g., overall pairing match, spiciness, etc.). The study used two pizza samples: one non-spicy and one spicy. To minimize effects of other potentially competing food elements, both pizzas utilized the same ingredients, measured amounts, and cooking method (with the exception of crushed red pepper added to the spicy version). The three beers for this study were selected to allow differentiation among three general styles: lager, ale, and stout. The beers range in an ascending order in both body style and hoppiness (bitterness). For the tasting, the international bitterness unites (IBUs) for each beer were as follows: Trailhead lager at 18, Wellington S.P.A (ale) rated at 23, and Imperial Stout at 50.

Impact

An individual's preference for a particular type of beer had a large impact on their beer selection with beer-friendly food such as non-spicy pizza. While beer preference was also an important factor for the selection with spicy pizza, the relationship was greatly reduced with individuals selecting fuller-flavored, fuller-bodied beers to match flavor intensity and persistency of the pizza. Therefore, spiciness in food has an important impact on perceived level of match and ultimately on customer satisfaction.

While a greater percentage of females selected a lighter beer as their initial preference compared to the males, we saw the greatest change in beer selection for females based on perceived level of match when spiciness was introduced. Therefore, an interesting finding is that, while females seem to prefer to consume lighter beer as a beverage by itself, they seemed to perceive the value of matching intensity levels based on food selection. This provides an interesting conundrum for practitioners in the field.

The importance of this study relates to opportunities for pizza and other restaurateurs to differentiate themselves from the competition. For instance, understanding the buying habits of consumers that purchase beer can help restaurateurs identify characteristics of their customers. Specifically, understanding these buying habits can help restaurateurs design an appropriate beer and pizza product mix.

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Funding

Social Sciences and Humanities Research Council of Canada, Wellington Brewery (Guelph, Ontario, Canada); Division of Agriculture, University of Arkansas System

Contradictions of traditions and change in German winemaking: An exploratory study

Issue

This exploratory study investigates the national adoption of international wine industry trends in Germany. Specifically, we consider this adoption as perceived by luxury German wine producers in three wine regions. This study addresses two main questions: What impact do regional German traditions have on techniques used by small wine producers in the super-premium+ segment? Are these traditions balanced with the adoption of New World techniques and trends in viticulture and viniculture?

Action

The researchers did semi-structured interviews with five highly respected German winemakers in the Rheingau, Württemberg, and Baden regions. This study shows that German wine producers are heavily influenced by Old World philosophy and traditions as well as New World concepts and technology. Successful wine producers appear to create a balance between the gastronomic identity of the region with advantages of new technologies, business models and trends.

Impact

This exploratory study was published in the International Journal of Wine Business Research (2008 - Volume 20, Issue 3, pp. 276-293) and provides several implications for small to medium-sized wine producers in Germany. First is the issue of convergent and divergent relationships and identity. This dichotomy has implications for balancing the convergence of "identity" to an area (based on tradition and regional capabilities) with the divergence of "identity" to an individual firm (based on innovations and in many cases resurrecting "lost" traditions). German wine producers and other small producers should look at Brunello di Montalcino as a model that enabled exploiting its unique combination of tradition and modern approaches. In this setting, regional producers managed the equity of its territorial brand, recognized the value of "identity" in its business model, and were assisted by leading firms to create a model of product integrity and marketing savvy.

To be successful in the current global wine trade, locations need to create a unique bundle of product characteristics that add value to consumers. Successful Old World producers provide an example of constant improvement of product performance, create appropriate logistics in retail distribution channels, and create a symbolic appeal for its products. Successful New World producers engage in more consumer-oriented approaches to tactical decisions (varietal selections, market-oriented innovations, and updating tastes that appeal to young and informal audiences), and understand the growing role of media or key opinion makers. The producers in this study attempted to integrate these concepts but found limitations based on firm size and availability of human resource capabilities. While luxury brand components of culture, history, and product integrity can be achieved to some degree at the individual firm level, collective marketing efforts and event endorsements can resolve key luxury brand component issues that appear to be lacking in this small wine production setting.

This issue is difficult to resolve given an industry of individual owners and individualistic traditions. One way to break down this issue is to present a case for: "What's in it for me?" or "How can a collective effort help me achieve my goals?" This concept appears easier than its reality and the difficulty of creating synergistic relationships in a fragmented industry setting has been demonstrated in research for more than two decades. This process seems likely to be more successful in situations where leaders combine leadership competencies and marketing competencies.

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Development of entrepreneurial innovations in the IT sector: Identifying levers for success

Issue

Although many IT firms recognize the importance of new service development (NSD), the process of how to create and design IT innovations it is not always clear. While earlier research has supported the importance of effectively designed structures and professionally implemented processes to create an organizational environment that enhances constant innovation, little empirical research has been completed to assess the impact of specific NSD process activities on success and failure in the entrepreneurial IT sector. Therefore, the purpose of this study was to investigate the NSD process used by small firms in the IT sector. Specifically, we evaluated which process activities are significantly related to the success and failure of entrepreneurial IT new service development projects. The majority of NSD studies and NSD process models has concentrated on large organizations and has neglected small, entrepreneurial service firms.

Action

Exploratory interviews and the literature review revealed four factors linked to successful new service development processes: NSD pre-launch activities, NSD process management, launch preparation, and effective marketing communication. A questionnaire was then sent to 228 German entrepreneurial IT firms in the Stuttgart area (Germany). Criterion for inclusion in the study was that the organization had developed new IT services over the past three years and employs fewer than 250 persons (defined as small and medium-sized enterprises). Completed data on 26 successes and 30 failures were received for a total sample of 56 new service projects.

Impact

This investigation has shown that innovation success and failure in small and medium-sized IT firms has similarities and differences to models of new product development used by large and product-oriented organizations. Successful entrepreneurial IT innovation projects appear to result from an iterative, flexible, and process-mindful approach to the NSD innovations. These findings highlight the critical importance of managing the process to 1) engage customers, management, and others during pre-launch, launch, and implementation; 2) facilitate innovation champions to aid in

idea generation and commitment to the project; 3) utilize an integrated process management system to heighten barriers to imitation; 4) create a culture that sustains this innovative process; and, 5) effectively communicate the benefits to both internal and external customers.

Therefore, implicit in this discussion is the need for entrepreneurial innovators to utilize three dimensions of intellectual capital: human factors, structural elements, and relational factors. Human factors relate to worker capabilities in this instance and include project commitment, innovation champions, and an ability to generate new ideas. Structural elements relate to factors that impact the process, in the case of NSD: supporting flexibility, entrepreneurship, risk-taking, and organizational learning. Finally, relational factors relate to developing associations with customers, partners, and the broader community throughout the innovation process.

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Division of Agriculture, University of Arkansas System

Inspiring the kitchen: Gender differences in the innovation strategy approaches used by chefs

Issue

While numerous attempts have been made to understand creativity and idea generation in the workplace, little investigation has been provided in a chef-restaurant setting. Most previous research in hospitality has focused on the new product development process as a whole and the factors related to hospitality innovation success. Recent, research specific to restaurants has been dominated by assessing male chefs only and have primarily focused on chefs outside of North America. Thus, this exploratory study intends to address a gap in the literature regarding innovation strategy approaches used for daily feature development comparing differences based on the gender of the chefs involved. Specifically, this study investigates: What is the innovation strategy approach used by chefs when creating a daily feature? And, does this innovation approach differ between female and male chefs?

Action

The research process consisted of conducting a total of eight interviews. Four female and four male chefs from the Toronto area were selected to participate. The research was intended to provide the investigator with an understanding of the factors that influence and inspire chefs to create new products, in the form of a daily feature. Prior to the 8 interviews, a series of four pre-test interviews were conducted with two male and two female chefs from the Ottawa area. The pre-test ensured that all questions from the instrument were clear, concise, and addressed the key research objectives.

Qualitative research was used for this study because the focus of the research is not on numbers but on words and observations. The investigator was able to find more depth in the research when the participants were given the opportunity to tell stories, provide visual portrayals, interpretations, and other expressive descriptions

Impact

From the open-ended questions, the investigator found three preliminary themes that indicate a gender-specific approach to factors that drive the innovation strategy of chefs during the new product development process. These include: the development process, a formulated strategy, and when idea formulation begins. In addition, the investigator will present two further themes that were found to be important to inspiration and the new product development process but did not provide any gender-specificity: where ideas come from and a formal versus an informal process.

Differences between male and female responses were also apparent in respondents' choice of top issues considered when determining daily features. For example, female chefs indicated product quality was the key variable when deciding on a daily feature; whereas, male chefs indicated the top variable in this decision was customer feedback.

Many variables influence how chefs, both male and female, generate ideas and the strategy used to create innovative daily features in their restaurants. Differences in the approach used by men and women in this endeavor has important implications for employees, employers and, ultimately, for customer satisfaction outcomes. Findings from this exploratory study provide important predictors in this regard. Further, this study provides a platform to drive future empirical research about gender differences in innovation strategy approaches and differences in how to manage the process.

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Gastronomy tourism: A snare for Asian heritage travelers?

Issue

While the importance of gastronomy as a motivator for travelers has been described both anecdotally and (to a lesser degree) empirically, a problem remains in terms of designing gastronomy tourism products and services that appeal to the

culinary traveler. While models of consumer choice with respect to food choices suggest that a variety of factors impact selection (political, economic, cultural, psychological, and marketing influences), more recent research in the gastronomy tourism area indicates the importance of issues such as feelings, memories, and gastronomy-tourism lifestyle preferences.

With growing interest in culinary tourism and Asia projected as the fastest growing tourist destination for the next decade (UNWTO, 2008), a valuable addition to the literature would be a greater understanding of the influences that drive culinary tourism demand, in general, and interest in culinary tourism by potential travelers of Asian descent in particular. Therefore, this exploratory study considers the influences and outcomes of Asian food travelers.

Action

First, the study synthesizes previous models of food purchase motivations and employs a narrative-analysis approach to create a framework of gastronomic traveler's motivations using sensory, psychological, and social perspectives. The study provides findings on how and why travelers are attracted to gastronomic destinations. Second, the study was implemented using a qualitative, narrative method. The in-depth interview protocol was divided into four sections and each section took about an hour (approximately 4 hours per case). The interview responses were translated from the interviewees' mother tongue (Mandarin Chinese) to English, then back to the original language to ensure accuracy.

Impact

Gastronomic experiences and memories may be the most valuable souvenirs of a vacation because they help people to distinguish between regional cultures in emphasising their special nature. What travelers want is to experience the depth and authenticity of local culture. Practitioners can think of their tourism product as a "unique" bundle of activities. A potentially beneficial part of this bundle is the gastronomic elements based on identity. The development of this model in general and in Asian markets in particular appears to have substantial consequences for successful wine tourism and culinary tourism by adding value-added features such as history, storytelling, and authenticity.

The first step in this process is performing an asset inventory that considers the following key issues: What are your destination's unique culinary assets? What is the unique bundle of activities that make up a total experience? What is needed in terms of capabilities, resources, and infrastructure? And, how can these be integrated with consumer sensory, psychological, and social needs? This process is not a "one size fits all" proposition for either product development or for the consumer. Methods shown to increase the uniqueness for both supply and demand are techniques such as reconfiguring the food supply chain to maximize local supply and creating a centralized concept of "identity."

Both of these issues require a collective effort of players from all links (e.g., market access through co-operatives; longer-term relationships to source locally; clear strategy and goals [tangible and intangible outputs]; engaging stakeholders early on; etc.).

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Resource allocation decisions and organizational structure

Issue

The question of how to structure an organization along with the causes and consequences has been studied from individual, group, departmental, unit, and organizational perspectives. Early studies point to the idea that organizational structure provides both a limiting factor for organizations (i.e. there are limits to our ability to successfully implement strategy due to our structure) and an impact in relation to strategic choice (i.e., strategic leaders' ability to design structure to adapt to strategic needs). While issues relating to resource allocation decisions and organizational structure are many, this study provides a discussion of its application for firms in the hospitality industry. The application section considers resource allocation decisions and organizational structure issues for entry into a fast-growing foodservice business segment. Specifically, the emerging trend of channel blurring between retail and foodservice is discussed in order to demonstrate the impact of level of control considerations, resource availability, and demand uncertainty on structural decisions. This example highlights key resource allocation decision issues for this strategic option.

Action

The separation between restaurant food and grocery store food has slowly dissolved over the past two decades. With the advent of the ready-to-eat, prepared food counters in most full-service grocery stores and retail super-centers, the retail industry has made inroads into the foodservice market. A report on global pricing trends described this nontraditional strategy as "channel blurring." In this study, restaurant-branded products are defined as food products that are tied to a specific restaurant brand and are made available in a food retail (grocery) environment. In other words, foods using restaurant brands that have transitioned from foodservice establishment to grocers' retail shelves. Very little research has been published on this contemporary food topic.

A framework is provided of key issues to consider when making resource allocation decisions in this area. The framework is based on our research on this topic drawing on earlier studies and in-depth interviews of knowledgeable executives involved with this segment of the foodservice industry. In evaluating the resource allocation options in this area, restaurant operators need to evaluate intangible resources such as their firm's branding, brand-equity, and brand

awareness to determine the value-added of their branded products. Additional issues directly related to determining resource allocations include retail viability, internal versus external implementation issues, and barriers to entry (costs and process).

Impact

Results were published in the Handbook on Strategy in the Hospitality Industry (pp. 235-264 [Elsevier Publications]). A key benefit of the channel-blurring process for the product expert and retailer is a reduced need to promote the new product as a brand, as the product benefits from existing brand equity of the foodservice operation. In many cases, this provides the retailer with an increased profit margin over typical national brands. By leveraging the capabilities of these three main stakeholders (foodservice operator, product expert, and retailer), this business model and collaboration benefits everyone involved including benefits to the retail consumer of less uncertainty and anxiety about the initial purchase of the food product. Organizational structure options in this example highlight a range of possibilities including organic and mechanistic forms, a variety of ownership forms to consider, and new organizational forms such as network, modular, and other hybrid arrangements.

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Arkansas biodiesel research, demonstration, and education project, year 2

Issue

A majority of all U.S. biodiesel is based on the methyl ester of soybean oil. Arkansas ranks among the top 10 states nationally in soybean production with an annual farm-gate crop value of approximately $500 million. Thus, the widespread use of soy-based biodiesel should provide economic benefits to both farmers and to rural communities in Arkansas. The University of Arkansas can play a leadership role in evaluating and promoting the use of biodiesel.

Action

Division of Agriculture researchers, Fayetteville campus Physical Plant personnel, and the Arkansas Soybean Promotion Board are cooperating in an applied research, demonstration, and education project evaluating and publicizing biodiesel (B20) as an alternative fuel for compression-ignition (diesel) engines. Seventeen Kubota RTV900-GT 4WD utility vehicles, operated by the Physical Plant, are being used in the research and demonstration components of this two-year project. In the research portion of the project, nine vehicles were randomly assigned to be fueled with B20 and eight to be fueled with petroleum diesel. The vehicles are being periodically tested to compare: fuel efficiency (l/h), fuel cost ($/h), exhaust emissions (ppm), and engine wear. In addition, controlled laboratory tests will be conducted using a new model of the same engine used on the RTV900GT 4WD vehicles. The demonstration component of the project focuses on the on-campus public visibility of the seventeen project vehicles. This visibility has been enhanced through the development and use of an eye-catching sign prominently displayed on each vehicle. Vehicles were displayed at five University of Arkansas home football games and project personnel were on hand to visit with the public about biodiesel. Project personnel have also developed materials and presented a number of one-hour educational presentations on biodiesel as an alternative fuel for compression-ignition (diesel) engines.

Impact

This project provides real-world, comparative data on engine performance, fuel efficiency, fuel costs, and exhaust emissions for compression-ignition engines fueled with B20. The project will also increase public awareness and knowledge of biodiesel.

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Arkansas Soybean Promotion Board; Division of Agriculture, University of Arkansas System; Arkansas Agricultural Experiment Station

Micro/nanoscale bio/abio interfacing technology

Issue

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

Action

Currently, we are in the process of developing a series of nano hybrid devices through stable and 'controllable' interfaces between bio and abio materials at the nanoscale. These devices as well as materials under investigation in my laboratory include (a) a nano flagellar motor based AC dynamo

(nFMD), (b) a nano flagellar motor based TNT detection system (nFMTNT), (c) a DNA-based CNT wire (DNA/NTW) nanosensor, and (d) a photothermal diagnostic and therapeutic system using near-infrared responsive nanoparticles.

Impact

These projects are important steps toward realization of the bio/nano nanotechnology that bridges the sciences of biology, medicine, nano-materials, and MEMS/NEMS by pairing their advantages.

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

Demonstration of a greenway development to protect ecological services in small urban streams

Issue

The city of Rogers, Ark., is part of the rapidly growing metropolitan area of Northwest Arkansas. In 2003, this area was determined by the Milken Institute to be the best performing metropolitan area in terms of business development. The urbanization of historically agricultural land has stressed infrastructure to the limit. Alternatives to the current practices are needed to maintain more natural conditions in the streams.

Action

A demonstration project on use of riparian corridors as greenway parks is being conducted by the City of Rogers, the Biological and Agricultural Engineering Department (BAEG), the Arkansas Water Resource Center, and Rogers Public Schools. A natural design is being provided to maintain ecological services in 4,900 feet of the Blossom Branch Creek. The BAEG conducted analysis of the ecological services, hydrology, and geomorphology, designed a greenway park, supervised construction of the project and is evaluating the results. Local and National technology transfer workshops have been held at the site for city planners, city engineers and developers to adopt more sensitive drainage practices in their development plans.

Impact

The City of Rogers, Ark., has adopted the Urban Greenway into its comprehensive growth master plan for the city. The first phase of the greenway was dedicated in August, 2006. Phase 2 of the project is under design by the EEG. Plans are currently underway to connect this demonstration with an additional 23 miles of greenway virtually encircling the city, and connecting with the trail system of the City of Bentonville, Ark. As a result, ecological services of the headwater streams draining this rapidly expanding town will be retained and the impacts of the development will be significantly lessened.

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U. S. Environmental Protection Agency; Arkansas Soil and Water Conservation Commission; Division of Agriculture, University of Arkansas System

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 the algal turf scrubber (ATS) test bed 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 CER and will be consistent with methods used at other project sites (Potomac River, Susquehanna River) so that direct comparisons of data can be made. Samples of algae from the ATS test bed will be dried and weighed to establish productivity rates. Some samples will be analyzed for nitrogen and phosphorus content, either once or twice per month. Other samples will be sent off for further analysis at the Smithsonian Institution and at Western Michigan University.

Impact

A demonstration-scale algal turf scrubber was constructed in Springdale, Ark., and operated for five months in 2008. Algal production efficiency and effectiveness are being evaluated.

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Funding

Division of Agriculture, University of Arkansas System

Implementation of low-impact development best management practices to remediate sediment from urban development in Fayetteville, Ark.

Issue

Northwest Arkansas is the sixth fastest growing Metropolitan Statistical Area in the U.S. The cities of Northwest Arkansas include Bentonville, Rogers, Springdale, Fayetteville, and Siloam Springs. These cities are located in both the Illinois and White River watersheds. These water-

sheds receive wastewater discharge from most of the metropolitan communities in Northwest Arkansas and are a source of concern and conflict because of sediment and phosphorus loading to the Illinois River (Arkansas and Oklahoma) and the White River (Beaver Lake). 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 non-point 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 an 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 system in Northwest Arkansas, and 4) develop and implement educational workshops for LID technologies.

Impact

Fayetteville, Ark., sits on the watershed divide of the headwater streams of the Illinois and White river watersheds and is rapidly urbanizing. Streams in the headwaters of these rivers provide critical ecological services for treating and removing pollution from the urban watershed. BMPs in ecological engineering alone, however, will not change non-point 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

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Basis-trading simulation software to develop grain merchandising and risk management skills

Issue

Risk management and basis trading are key activities for agribusiness firms involved in the procurement, merchandising, processing, and marketing of grain and other commodities. The importance of these activities has been highlighted by globalization, which has led to increased price volatility and competition for U.S. grain. The grain industry is international in scope with major players such as Cargill and Archer Daniels Midland (ADM) buying and selling grain within hundreds of countries worldwide. Evidence of globalization of the grain industry is visible in terms of elevator bids at major U.S. ports, which reflect international supply and demand conditions. Price shocks to world grain markets are quickly transmitted via bids at these ports to the hinterland (McKenzie, A.M. "The Effects of Barge Shocks on Soybean Basis Levels in Arkansas: A study of market integration." Agribusiness An International Journal 21(1) 2005:37-52). However, a major advantage of U.S. grain industry over foreign competition is ease of access to developed commodity risk management markets (e.g., Chicago Board of Trade futures and options markets). In order to remain competitive, merchandising firms increasingly rely on basis trading skills, which developed alongside the futures markets, to provide a cost-effective yet profitable service to grain buyers throughout the world. Thus globalization can be seen as a driving force behind greater price risk and increased competition within the U.S. grain industry. With this in mind, the grain industry's need for students with price risk management and basis trading skills has never been keener. However, there is a lack of undergraduate agribusiness course materials on basis trading and risk management education at the merchandising level of the grain industry, where most agricultural risk management activities occur and where many employment opportunities for students are found. Existing university risk management course materials focus exclusively at the farm level.

Action

A basis-trading software game, developed at the University of Arkansas to teach merchandising and price risk-management skills, has been made available at the following Department of Agricultural Economics website: http://www.uark.edu/ua/btrader/

Basis Trader is an engaging risk-management game using computer technology to provide an experiential learning experience that develops students' analytical decision-making skills at an applied level. It explores concepts such as basis trading and hedging by simulating basis movement, historical basis patterns, inventory management, and the procurement and sale of grain based upon actual data collected from grain elevators in Arkansas, Tennessee, Illinois,

Kansas, South Dakota, and Wisconsin. Players take on the role of grain merchandisers seeking to market corn, soybeans and wheat, and can choose from a number of different market locations. Players are faced with a number of marketing and risk management decisions, including the following: how much grain to hedge; what contract months to hedge against; how long to store grain; and when to sell it. Problem-solving skills are emphasized in terms of making marketing decisions with respect to current and historical futures spreads, current and historical basis levels, elevator storage capacity, and the cost of storing grain over time.

Impact

Important outcomes and impacts of the game and materials will include the fostering of a better educated student body with the skill set and motivation needed to pursue successful careers within the grain industry. This potential workforce will help U.S. grain industry remain competitive and better serve the needs of the general economy. Tangible outcome measures will be represented by: more institutions incorporating the project materials in marketing and risk management courses; improved scores in risk-management course tests; increased student enrollment in agribusiness marketing and risk management classes; and an increased number of students seeking internships and full-time career opportunities in the grain industry. It is hoped that agribusiness programs from land-grant universities and colleges throughout the country will adopt the project materials within their curricula. The game and materials will also provide farmers across the nation with the opportunity to more fully understand the intricacies of the grain marketing system beyond the farm gate.

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Impact of mosquito management on health and quality of life

Issue

The rice-growing areas of Arkansas are plagued annually by hordes of mosquitoes. Urban sprawl has brought people nearer to the source. Urban and rural communities need to manage mosquitoes whether they emanate from rice lands or from non-agricultural habitat. Accessibility of breeding habitats in irrigated croplands is an agricultural problem that exacerbates the irritation and level of disease risk for humans and domestic animals. The potential for disease from riceland mosquitoes certainly exists. Malaria is uncommon in the U.S.; however, sporadic transmission occurs because riceland mosquito vectors are present and serve as hosts for imported malaria parasites. West Nile virus and St. Louis encephalitis are also vectored by certain riceland mosquito species. Dog heartworm and anaplasmosis affect domestic animals and are vectored by riceland mosquitoes. Unfortunately, insecticide effectiveness against mosquitoes is in a noticeable decline. Given the lack of new chemicals, alternate or improved means of control with existing compounds must be investigated.

Action

Mosquito management programs have changed very little over the past several years. Indications of insecticide resistance are appearing in some rice-growing areas and programs continue to be defensive and pesticide dependent. An integrated approach that is economical, environmentally safe and socially acceptable is needed. An urgent need exists for research to optimize the non-chemical approaches and to use more judiciously the chemicals currently available. Studies were conducted to determine insecticide susceptibility in rice growing areas of Arkansas and Mississippi. Various new larvicide formulations were tested.

Impact

Improved mosquito management methodologies add to protection of humans and animal health and quality of life. Experiments to ascertain the efficacy of various larvicides should lead to more effective measures employed in control of mosquitoes Less waste and environmental contamination due to better or more accurate application actually striking the target site offer benefit as well. Research to determine the efficacy of barrier treatment with an environmentally persistent pyrethroid in an area containing a dense mosquito population will reduce pesticides used. These studies should lead to more effective measures employed in control of mosquitoes with less waste and environmental contamination.

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Educational needs in the Arkansas agritourism industry

Issue

The recent rise in popularity of agritourism operations across the nation has begun to pique the attention of farmers and landowners in Arkansas. Enterprises such as pumpkin patches, pick-your-own orchards, on-farm farmers' markets, Christmas tree farms, winery tours, and private nature trails are becoming more common across the state. Some experts view adding an agritourism enterprise as a sensible method of making a family farm more economically diverse and sustainable. With this rise in popularity of agritourism businesses, it follows that increasing numbers of farmers across the state are seeking to learn more about starting and managing an agritourism enterprise. The logical place for

them to go for information is the University of Arkansas System Division of Agriculture. Therefore, in preparation to meet this demand for educational materials, Division of Agriculture researchers are surveying agritourism business operators in Arkansas to determine the educational needs that they, themselves, believe are most pressing.

Action

Working in conjunction with the Winthrop Rockefeller Institute (WRI), Division researchers have developed a telephone survey of 370 known agritourism business owners in Arkansas, as identified by educational program coordinators at WRI. This survey, which is a part of a larger economic impact and public policy study, will identify the most important topics, practices, and skills that agritourism business owners want more education about. In addition, their preferences regarding educational delivery methods will be determined in preparation to develop the types of educational programming the industry most desires, such as seminars, webinars, workshops, industry tours, online courses, or other types of educational programming that could serve this growing industry.

Impact

The results of this study will provide guidance to several organizations, including the Winthrop Rockefeller Institute, the Division of Agriculture, and the Arkansas Agritourism Initiative in developing educational materials and programming for the agritourism industry in Arkansas. Ultimately, these well-guided educational efforts should lead to more successful agritourism businesses and, therefore, to more profitable family farms across the state.

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Land-use effects on near-surface levels of arsenic in soils of Northwest Arkansas

Issue

Arsenic (As) is a highly toxic element that occurs naturally in most soils at low concentration (5-10 mg As/kg soil). However, various human activities (e.g., pesticide applications, the production of treated lumber) can result in much higher soil As levels. Northwest Arkansas was the epicenter of the U.S. apple industry in the late 19th and early 20th centuries. At that time, the primary insecticide used in apple production was lead arsenate. Significantly elevated levels of soil As have been reported in other states that had large apple industries. In addition, much of the poultry litter applied to pastures in northwest Arkansas contained As because for many years As was added to poultry rations to control intestinal parasites in the birds. Therefore, in northwest Arkansas old orchard soils and/or soils heavily fertilized with litter may contain elevated levels of As. The purpose of this study was to determine if previous land use (apple production or littered pasture, or both) affected near-surface As levels in northwest Arkansas soils.

Action

Near-surface (0-2, 2-4 and 4-8 cm) soil samples were taken from a total of eleven sites in northwest Arkansas. These sites were divided into four treatment groups. Aerial photographs taken in 1940 and landowner interviews were used to identify old orchard sites not subsequently converted to pasture ("historic orchard") and old orchard sites subsequently converted to pasture ("historic orchard/pasture"). Property owner interviews were used to identify littered pastures that had never been in orchard ("pasture") and sites that had never been in orchard and had never received any litter ("control"). Acid-recoverable (EPA Method 3050B) As, lead (Pb) and phosphorus (P) were determined in all samples. The highest levels of As were found in soils in the historic orchard/pasture treatment, followed by soils in the historic orchard treatment, and then soils in the pasture and control treatments. The average soil As concentrations at all depths in the historic orchard/pasture treatment exceeded the USEPA's Preliminary Remediation Goal (PRG) for As in soil of 22 mg As/kg soil. Also, soil As concentrations increased with depth in this treatment. In the orchard-only treatment, soil As levels were elevated relative to levels in the control treatment, and average soil As levels at all depths were very close to the USEPA's PRG of 22 mg As/kg soil.

Impact

Historic orchard soils in northwest Arkansas have a high probability of containing elevated levels of As. While we will never know the precise extent of the acreage impacted, it has been estimated that in 1919 approximately 80,000 acres of land were being used for apple production in Benton and Washington Counties. Therefore, it is possible that this same number of acres of soil contains elevated levels of As. Northwest Arkansas is one of the fastest growing areas in the US, which means that it is quite possible that historic orchard soils containing elevated levels of As are being converted to residential areas, gardens, etc. Other states (e.g., Wisconsin) with similar concerns have developed soil As testing programs, and Arkansas may want to consider doing the same. Our results indicate that land application of broiler litter has no effect on soil As levels, although application of litter to historic orchard soils does appear to mobilize As and allow it to move deeper into the profile.

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Local government finance

Issue

Many Arkansas counties, particularly in the Delta and the Coastal Plains, are rapidly losing businesses, employment opportunities, and population. These losses reduce the tax base and ability of county governments to generate revenue to pay for needed infrastructure and services. This crisis could lead to underinvestment in the infrastructure and services needed to support a viable and growing economy in an increasingly competitive global economy.

Action

Our first actions are making county leaders aware of the potential fiscal crisis given current economic conditions in rural Arkansas and provide them with the tools to continually analyze their financial situation. Simultaneously we are providing county leaders with alternative ways to maintain their services and infrastructure within the environment of stagnant revenue and increasing costs.

Impact

The Association of Arkansas Counties is supportive of our work and participated in the 2006 local government finance workshops for county staff chairs. During 2007 the Searcy County Judge requested we make a presentation to the Quorum Court members to discuss their current and future fiscal situation and options on how they could continue to provide needed services and infrastructure.

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Cooperators
Conducted workshops for county faculty using the findings from the research

Funding:
University of Arkansas Public Policy Center; Division of Agriculture, University of Arkansas System

Rural economic development

Issue

Many rural Arkansas communities are rapidly losing businesses, employment opportunities, and population. New economic development opportunities must be identified and implemented if rural communities are to remain economically viable.

Action

A research project was undertaken to identify and evaluate the past, current, and future economic base of Arkansas's North Central Region. Given the resource base, competitiveness of current industries, and growth potential, appropriate economic development strategies for north-central Arkansas were identified. A Rural Profile of Arkansas was also produced that identified economic and social differences between urban and rural areas and highlighted the social and economic needs of many rural areas of the state.

Impact

This research was requested by regional leaders and they used the findings to organize committees to implement some of our recommended economic development strategies for the region. Our Rural Profile of Arkansas is utilized by legislators and state government officials to identify major social and economic differences between rural and urban areas of the state that need to be addressed.

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Cooperators
Conducted workshops for NCARED regional leaders using the research findings

Funding:
North Central Arkansas Regional Economic Development Association (NCARED); Division of Agriculture, University of Arkansas System

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

Issue

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

Action

In response to the need of new applications for co-products and by-products from the food industry and specialized crops, researchers in the University of Arkansas Division of

Agriculture have been working on the depolymerization of protein co-products from different sources using green technologies. Enzymes and superheated water are currently used to hydrolyze protein co-products to different degrees of hydrolysis, which generate free amino acids and peptides with diverse functionalities.

Impact

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

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Funding:

Hatch funds; Division of Agriculture, University of Arkansas System

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 System's Division of Agriculture established in 1995 the Institute of Food Science and Engineering to assist food processors in framing issues, focusing efforts, and solving problems. The Institute promotes and supports research to assist industry in solving its research problems, both fundamental and applied. The goal is to create partnerships among private companies or industry groups and university scientists and extension specialists from a variety of disciplines and departments, transcending traditional institutional boundaries that can be barriers to cooperation. The Institute's multidisciplinary research expertise offers an integrated approach to developing and disseminating scientific information associated with production, value-added processing, safety, nutritional value, packaging, storage, and distribution of food products. The Center for Food Processing and Engineering's primary objective is to facilitate research leading to value-added products and improving the efficiency and effectiveness of the processing of agricultural products. Activities of the Center for Food Safety seek to maintain or improve the safety of foods through production, harvest, processing, distribution, and storage. A new emphasis is creatively applying fundamental-based science to resolving food safety issues. More natural and less-known host defenses and host preventive strategies are being investigated as important components for manipulation and application in food safety programs. The Center for Human Nutrition and Functional Foods evaluates value-added functional foods with elevated levels of health promoting compounds. Its main thrust is the evaluation, and enhancement, of important phytochemicals present in fruits, vegetables, grains, and legumes grown in the Southern region.

Impact

The Institute of Food Science and Engineering has sponsored 94 specific research projects, in addition to general research in eleven major research program areas, in the past thirteen years, partnering with 158 companies from 34 states and 7 foreign countries. Arkansas is the leading rice-producing state. Thirty-four major rice processing companies, accounting for the vast majority of rice processed in the United States, have financially supported the Rice Processing Program sponsored by the Institute. Rice processors have never before participated in a joint research program "for the good of the industry" on this scale. The Program encompasses five main areas of research emphasis: drying, storage, milling, quality assessment, and the cereal chemistry of rice and rice products. Rice processors are gaining new understanding of factors that affect yield and quality of processed rice products. This information is impacting operations ranging from harvesting and storage of head rice to milling operations and storage of processed products. The economic benefit of this research is tremendous. As an example, a single project promises an improvement in head rice yield that could increase industry returns by seven million dollars annually. Other major program areas are processing of vegetables and fruits, wine and other grape products, pickled vegetables, rheology and sensory, functional foods, thermal processing of value-added poultry products, lipids and oils, and soy products. Completed sponsored projects in the area of vegetable processing provide industry with millions of dollars of increased returns annually. The patented vineyard mechanization systems have been commercialized. The sixth year of field trials in California has been concluded, demonstrating labor cost reductions while maintaining or improving yield and fruit quality. When widely adopted, many millions of dollars will be saved annually. The thrust to provide small farmers and entrepreneurs with information about the production, development of affordable further processing techniques, analysis of accessible marketing channels, etc. of value-added horticultural products continues. Publications include over 340 refereed articles and 16 other publications. University of Arkansas resources developed or enhanced through Institute programs include a unique, professionally trained descriptive sensory panel for analysis of diverse food products, thermal processing capabilities, and a product

development kitchen for product development and improvement. Food quality and safety activities have included joint efforts to assure that imported products meet U. S. standards for quality and safety.

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The impact of motivational inducement of a training program on employees' outcome

Issue

Past studies indicated that individuals' performance and contribution to an organization are closely related to an exchange for inducements. If encouraging inducement is maintained, individual loyalty and performance will be maintained. It could also be argued that if motivational inducement prior to training is not fulfilled after training, it is more than likely that individual loyalty and performance in the organization might not be maintained. Little attention has been devoted to studying how following up with motivational inducement prior to management training, affects hospitality managers' potential commitment to the organization after training. Thus, the study explored the effect of motivational inducement of a training program on the final outcome of the management.

Action

Qualitative and quantitative procedures were used to examine the training program of a hospitality organization. The objectives of this study are threefold: to examine the consequences of pre-training motivational inducement on trainees' behavior, to examine the consequence of post-training motivational inducement on trainees' behavior and, to examine the consequences of fulfilled, or unfulfilled motivational inducement on post-training commitment among the trainers. Due to unfulfilled motivational inducements, almost all the trained potential managers and trainers quit the organization. Thus, new employees were not trained properly and the goals of the training program were not achieved.

Impact

This study indicated that if employees' motivational inducements are not fulfilled there is a great chance for commitment to decrease. The researcher gathered that these kind of unfulfilled promises could result in a feeling of mistreatment among employees and lead to the reverse of the intended outcome. A practical implication of this study is that leaders seeking improvement in organizational performance should pay more attention to intrinsic motivational tactics and achievable extrinsic motivational tactics in order to maintain the steadfastness of their staffs. Hence, organizational leaders should learn to keep their promises or focus more attention on achievable inducements in their motivational efforts.

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Funding
Division of Agriculture, University of Arkansas System

The impact of leadership styles of foodservice managers on subordinates' performance

Issue

Path-Goal Leadership (PGL) theory provides a framework for understanding how foodservice managers' leadership styles could influence subordinates performance and satisfaction. Path-goal leadership theory concentrates on how leaders can facilitate subordinates to accomplish their tasks by employing behaviors that match the subordinates' characteristics and the task attributes. Despite the application of PGL theory to explain the impact of variation in managers' leadership styles on subordinates' motivation, satisfaction, and performance, little to no research has been conducted to explore this topic in the hospitality industry. Past studies indicated that employees' perception about their leadership styles could influence employees' performance, and consequently organizational performance. Since employees' perception of their managers' leadership style can impact organizational performance, the purpose of this study was to determine if managers' perception of their leadership styles is in agreement with their subordinates' perceptions, and to determine which of the four leadership styles in this study are influential in predicting employees' motivation and performance.

Action

The investigator examined the leadership styles of foodservice managers and their subordinates' perception. Some of the objectives of the study are as follows: to determine whether managers and subordinates' agreement on leadership styles will have a positive relationship on performance and employee motivation, to determine if the four leadership styles are all effective for motivating employees at work, and to determine if the four leadership styles are all effective in influencing the employees to get the job done. The result of the study indicated that not all the subordinates agreed with the perception of the managers in terms of the leadership styles the managers displayed at work for motivating employees, and influencing employees to get the job done. The result of the first objective indicated that managers and subordinates' agreement on leadership styles was influential in predicting employees' motivation and intention to get the job done. Regression analysis indicated that supportive and directive leadership styles were more influential in predicting employees' intention to get the job done while supportive, participatory, and achievement-oriented leadership styles are influential in predicting employees' motivation.

Impact

This result indicated that managers have the tendency to rate their leadership styles differently from the perception of their subordinates. A manager might think that he or she is highly supportive when the subordinates think he or she is low in supportive leadership styles. Similarly, a manager might think that he or she is high in participative leadership styles whereas the subordinates think he or she is low in participative leadership styles. Therefore, foodservice managers who are not aware of how their leadership styles are perceived by their subordinates could hinder their organizations from quality improvement, because leaders' actions that are expected to inspire and motivate employees may be ineffective, and the leaders' actions could be the opposite of what employees really want or need to positively impact the organizational performance.

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Funding
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Generation of recycling materials at multi-family dwellings

Issue

As Northwest Arkansas continues to grow at a rapid pace, viable options for household waste disposal are decreasing. Currently many of the cities, such as Fayetteville offer a curbside recycling program for single-family households but these programs fail to capture recyclable materials that may be generated at the nearly 14,000 apartment units and other multifamily dwellings within that city alone.

Action

A full sampling of a Fayetteville apartment complex residents' disposal activities was studied over 4-8 week intervals during a two-year period. Using the City of Fayetteville's approved recyclables list, a complete inventory of recyclable items was quantified during the study period. The average total recyclable generation rate ranged from 1.97 kg/person/wk to 2.77 kg/person/wk across the periods. Fifty-two percent of the average resident's generated weekly solid waste was recyclable– an amount that would likely have been noticeably higher had compostable materials been included under recyclable categories.

Impact

Cities looking to promote sustainability initiatives as well as to identify potential new sources of income generation may be interested in the development of multi-family dwelling recycling programs. However, such programs come with their own costs. Policy makers need empirical knowledge of the composition, variability, and generation rates of recyclables associated with the waste disposal behavior of such residents. This study offers some of the first such detailed information available to policy makers in Northwest Arkansas.

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Funding
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A mobile demonstration unit for biodiesel education

Issue

There is a great deal of public interest concerning alternative fuels for internal combustion engines, especially compression-ignition (diesel) engines. At the same time, there is quite a bit of erroneous information concerning biodiesel and its manufacture, performance characteristics, and emissions byproducts.

Action

A Division of Agriculture research team developed instructional materials and a mobile demonstration unit for public educational programs on biodiesel as an alternative fuel. The educational program consists of a 1-h multimedia PowerPoint© presentation on the basics of biodiesel production and engine performance characteristics. The demonstration unit consists of a 3-cylinder compression-ignition engine (28 kW @ 3200 rpm), two scale-mounted fuel tanks, tank selector valves, a computer-controlled water brake dynamometer with display screen, and a portable exhaust gas analyzer. The engine can be operated from either fuel tank (one contains No. 2 diesel and the other contains biodiesel) and comparisons of engine performance (power and torque), fuel efficiency (kg/kWh), and exhaust emissions (CO, CO_2, O_2, NO_x, and unburned hydrocarbons) can be made.

Impact

This project will provide much needed hands-on education related to biodiesel production, use, and performance.

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Arkansas Soybean Promotion Board; US Department of Energy; Division of Agriculture, University of Arkansas System; Arkansas Agricultural Experiment Station

Antibiotic-resistant bacteria in a stream receiving wastewater treatment plant effluent

Issue

Incomplete elimination of antibiotics and bacteria in wastewater treatment plants (WWTP) has been reported. Very low levels of antibiotics had been measured in Mud Creek in Fayetteville, Ark., when it received effluent from a local WWTP. Whether there are measurable impacts of antibiotic-resistant bacteria and low levels of antibiotics from WWTP effluent on microbial communities in aquatic ecosystems is not well quantified.

Action

Water samples were collected upstream, downstream, and at the effluent discharge pipe in Mud Creek. *E. coli* were enumerated, and 85 isolates were characterized using antibiotic susceptibility testing and PCR amplification of the uidA gene followed by denaturant gradient gel electrophoresis. Electrical conductivity, dissolved organic carbon, and nitrate/nitrite-nitrogen increased downstream of the input of effluent discharge. Concentrations of total *E. coli* were similar upstream and at a second site downstream, though proportions of antibiotic resistance decreased at the farther downstream site. *E. coli* isolated from the effluent had more diverse compositions of multi-drug resistance (MDR) patterns and *E. coli* types, while stream sites had less diversity than the effluent. MDR pattern and *E. coli* types in downstream sites were different from upstream.

Impact

Our results suggest that effluent introduced *E. coli* and MDR patterns that were not found in the stream prior to the WWTP event, and this may have changed the structure of the microbial community in the stream ecosystem.

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Funding
USGS/Water Resources Research Institute; Division of Agriculture, University of Arkansas System

Nitrogen cycling and harmful cyanobacteria in reservoir ecosystems

Issue

Cyanobacteria are a group of phytoplankton (photosynthetic microorganisms inhabiting lakes, reservoirs, and oceans) that can degrade water quality by producing a diverse range of toxic and taste and odor producing compounds. Ecosystem nitrogen deficiency can favor the proliferation of cyanobacteria. It has been well established that accelerated eutrophication magnifies ecosystem N deficiency, but the mechanisms creating this pattern are poorly understood. Furthermore, we know very little of how ecosystem N deficiency may be affected by changing climate conditions.

Action

Studies are underway to assess ecosystem N deficiency and mechanisms that select for cyanobacteria in several reservoirs in Northwest Arkansas. Phytoplankton nutrient demand and nitrogen fixation rates by planktonic cyanobacteria are assessed regularly in Beaver Lake, Lake Wedington, Lake Elmdale, and Lake Fayetteville. The objective of this work is to quantify the role of cyanobacterial N fixation in driving cyanobacterial abundance in the phytoplankton. The mechanisms that potentially create N deficiency in these reservoirs are also being quantified. Reservoirs may experience greater N deficiency when river inflow is low because nutrient supply to phytoplankton during these periods is dominated by nutrient efflux from sediments. Sediment denitrification may decrease sediment N:P by removing nitrate from sediment pore water. Therefore, sediment nutrient regeneration may cause ecosystem N deficiency by altering the ratio of available N:P. Nutrient flux from sediments to overlying water and sediment denitrification rates are being assessed from both near-shore areas and deep-water areas. The objective of this work is to quantify the role of sediments as a potential nutrient source to phytoplankton and determine if the N:P ratio of nutrients regenerated in sediments may favor N-fixing cyanobacteria.

Impact

Results of these studies will help us understand why cyanobacteria become dominant under ecosystem N limitation and what factors are most responsible for causing ecosystem N deficiency. Results will also allow us to determine the role of climate in creating conditions favorable for nuisance cyanobacteria.

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Funding
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Identification of bacterial pathogens collected from Arkansas dog hosts

Issue

Arkansas contains more than 50 state parks across 33 million acres of land, providing outdoor recreation for countless visitors, and habitats ideal for wildlife and tick species. Ticks encountered most often include the Lone Star tick, the Black-legged tick, and the American Dog tick. Many of the state's locations provide habitat for wildlife that may serve as reservoirs for bacterial pathogens including *Ehrlichiosis* spp. (cause of Canine *ehrlichiosis*), *Borrelia burgdorferi* (cause of Lyme disease), *Rickettsia rickettsii* (cause of Rocky Mountain Spotted fever), and *Francisella tularensis* (Tularemia). These pathogens are readily vectored by ticks to domesticated and wild animals, humans, and dogs. Tick-borne pathogens are common across the country,

but Arkansas has yet to document their presence in tick and animal species. Although the state ranks among the highest in reported human cases of tick-borne diseases (incidences are steadily increasing), the tick and animal incidences have not been well documented.

Action

During 2008, ticks were collected from canine pet animals by cooperating veterinarians throughout Arkansas and portions of bordering states. Collected ticks were processed in our laboratory using molecular diagnostics to determine the tick species, and pathogens contained in the ticks and in blood collected from the pet animals. Blood samples from dogs and 1300 ticks, representing several species (*Ambylomma americanum*, *A. maculatum, Ixodes scapularis*, and *Dermacentor variabilis*), came from counties throughout Arkansas and one Missouri county. Numbers of ticks collected from dogs ranged from 1-24 ticks (mean = 6.71 ticks). Thus far, some 500 ticks have been sequenced indicating 2 haplotypes for *A. americanum* and 1 haplotype for *I. scapularis*. Fortunately none of the canines tested positive for any of the pathogens listed above; however, tick samples contained remarkably high percentages of pathogens. *Borrelia burgdorferi* was found in 7%, *R. rickettsii* was found in 33%, and *F. tularensis* was found in 18%. A majority of the positive ticks were adults. Of the *A. americanum*, 4% tested positive for *B. burgdorferi*, 30% tested positive for *R. rickettsii*, and 19% tested positive for *F. tularensis*. Of the *A. maculatum*, 7% tested positive for *B. burgdorferi*, 33% were positive for *R. rickettsii*, and none tested positive for *F. tularensis*. Of the *I. scapularis*, 13% tested positive for *B. burgdorferi*, 43% tested positive for *R. rickettsii*, and 29% tested positive for *F. tularensis*. Of the *D. variabilis*, none tested positive for *B. burgdorferi* or *R. rickettsii*, but 29% tested positive for *F. tularensis*.

In addition, 1569 ticks of five species were collected from 250 deer throughout Arkansas. A majority (88.8%) of the ticks collected from deer were the black-legged tick, *I. scapularis*, whereas less than 1% of the ticks from deer were the American Dog tick, *D. variabilis*. Ticks collected per deer ranged from 1-32, with a mean of 6.3 per deer.

Impact

The data obtained from the study will provide insight into areas of tick-canine-pathogen interactions as well as tick-deer-pathogen relationships. We will establish a database with current records updating tick diversity, colonization, extinction, and basic biological data. These data will provide information needed to develop integrated tick management strategies relevant to Arkansas residents, tourists, and pet animals.

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Division of Agriculture, University of Arkansas System

The 2008 Insect Festival of Arkansas

Issue

Arkansans are hungry for knowledge of insects and the roles they play in our lives. For instance, honey bees are extremely valuable for their pollination activity as well as honey and beeswax production. Recently Africanized honey bees have entered Arkansas. Their highly defensive behavior could lead to increased stinging incidents with the public. The public needs to know first hand about bees from experts. Termites are major pests of human-built wooden structures and Arkansas crops and trees are attacked by a wide variety of pests. Education of the public about beneficial and injurious insects is of great value.

Action

In October 2008, the entomologists of Arkansas put on the 11th Insect Festival, attracting around 2,500 people. This festival involved at least 58 volunteers, including 9 faculty, 13 graduate students, 16 staff members, and 20 entomologists from around Arkansas. The festival had exhibits on many different topics, including: apiculture/honey bees, cotton patch, aquatic insects, arthropod zoo, butterfly house, museum insects, games and crafts for children, cockroach races, and many scientific exhibits. The Festival has a strong "teaching/educational" component in addition to being entertaining.

Impact

Each time the Insect Festival has been held it attracts about 2,000-3,000 people. Over the years this means about 30,000 Arkansans have been impacted by the Festival. The Festival has had an enormous impact on educating Arkansas youth and general public about entomology and the role insects play in human welfare.

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Cooperators
Department of Entomology; other entomologists and friends of entomology

Funding
Dale Bumpers College of Agricultural, Food and Life Sciences, Department of Entomology; Division of Agriculture, University of Arkansas System

Genetic variation of Africanized honey bees in South-Central United States

Issue

The Africanized Honey Bee (AHB) in North America is a hybrid of one of the several European honey bee (EHB) subspecies and the African honey bee (*Apis mellifera scutellata)*. The hybrid is virtually indistinguishable in the field from the common honey bee. Population-genetics analysis of AHB in the United States has not been previously con-

ducted and may provide insight into the dispersal of AHB within and among states and aggressiveness of the subspecies.

Action

Honey bee samples were collected by the Arkansas Plant Board, Oklahoma State University, or by county extension personnel from various locations in Arkansas, Oklahoma, and New Mexico. DNA sequencing of the mitochondrial DNA COI-COII intergenic region was performed. For the COI-COII region, a total of six mitotypes were observed, of which, three had not been previously described. One new mitotype, A1a, was most similar to the previously reported A1, A4a, and A4b were similar to A4. Of the 102 samples subjected to DNA sequencing, the A1 and A1a mitotypes were the most common (83%), followed by the A4 mitotypes, and then the A26 mitotype.

Impact

The finding of multiple mitotypes of 'A' lineages in honey bees in the United States has been previously observed in South America and Mexico using PCR-RFLP. This is the first study to reveal that there are multiple mitotypes of AHB in the United States. This genetic variation may be used for monitoring the dispersal of this invasive insect in the United States, and could be used to determine if there is a genetic correlation with the 'aggressiveness' of this honey bee subspecies.

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Starch structure and properties of barley on malting and brewing performance

Issue

Malting barley varieties are the raw material that power the malting and brewing industry, and the quality of these varieties has a significant impact on the quality of malt and beer. New malting barley varieties have been developed based on malting, particularly diastatic power, and agronomic qualities to meet the increasing demand for better malting barley varieties. However, malt functional analyses cannot completely predict malt performance in a complex system across all breweries because many brewing characteristics cannot be adequately judged until commercial scale trials are conducted. Therefore, it is important to understand other factors that influence brewing performance. Presently, the information on the structure and properties of barley and malt with relation to brewing performance is limited.

Action

Food science researchers in the University of Arkansas System's Division of Agriculture have shown that the structure and properties of barley and malt strongly influence malting barley brewing performance. Twenty five pairs of commercial barley and malt samples were analyzed and compared for their chemical composition and fine structure. The results demonstrate that brewing performance is positively correlated with barley starch content, amylopectin long chains, and limit dextrinase activity, but negatively impacted by beta-glucan content, amylopectin branching structure, and starch gelatinization temperature.

Impact

Malting barley is essential to the brewing industry. New breeding lines are being tested for a number of important barely and malt quality factors. This work demonstrates the important contributions of barley starch composition and structure to brewing and provides new information for selection of barley with better brewing performance.

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Funding:
Busch Agricultural Resources LLC; Division of Agriculture, University of Arkansas System

Modeling historic landscapes using general land office surveys with indicator kriging and documenting changes that have occurred in the Buffalo River Sub-Basin

Issue

Forested areas in the United States have been altered since the time of European settlement. For this reason, research interests have increased in comparing present day vegetation with that of the pre-Euramerican era historic data to see what changes, if any, have occurred. Such studies have been conducted in other parts of the United States but little research has been done in Arkansas, and previous studies focused on species present/absent lists using the General land office (GLO) surveys. By incorporating geographic information systems (GIS) spatial modeling with pre-Euramerican settlement and present vegetation conditions it will be possible to provide a precise method of what changes have occurred in relation to geographic location.

Action

A script was developed to enter GLO survey notes, surveyed from 1830 to 1847, for the Buffalo River sub-basin into a Geographic Information System (GIS) point layer. More than 25,000 tree locations were entered. In addition, a similar method was developed to enter the 1999 forest inventory analysis (FIA) data into a point GIS layer for the same area. Indictor kriging was use to interpolate the GLO and FIA species-groups-point GIS layers to model the probability of a certain species group occurring at a specific geographic location. The model took into account distance, direction, and redundancy of neighboring points. The Mean

Predication Error for cross-validation ranged from -0.07 to 0.003 for GLO species groups with Cedar being closest to zero at -0.0002 and from -0.51 to 0.18 for the FIA interpolation with Dogwood being closest to zero. The Mean Predication Error for validation ranged from -0.52 to 0.71 for GLO species groups and from -1.64 to 2.42 for the FIA interpolation. Despite some sample variation inherent in the data due to differences in sampling frequency, all modeled values are fairly close to zero. The kriging model did a good job of predicting species geographic locations. Areas of no change comprised the single largest group at 95,864.3 hectares (27.6% of total sub-basin area) while 65,665.9 hectares (18.9% of total sub-basin area) went from forested to non-forested. The two most common groups of trees (white oak to red oak and red oak to white oak) had fairly large changes in area. Oak species had a cumulative loss of 17.4% to areas of no forest at the present and lost 14.5% of the sub-basin area to walnut/hickory. Additionally 6.1% of sub-basin area was lost to cedar.

Impact

Information on biodiversity of landscapes is available for many areas since the 20th Century; but prior to this time period, little is known over large areas. The GLO survey notes provide us with the only systematic on-ground survey from 1815 to 1850 in Arkansas, which predates most formal botanical investigations. Using indicator kriging, we can use known values at sample locations to estimate the probability of tree species or species group for unsurveyed areas. By exploring characteristics such as spatial patterns and variation we can gain insight into the Pre-Euroamerican landscape. The methodology developed in this research provides us with the first quantitative map of the Pre-Euroamerican landscape for the Buffalo River sub-basin. This research gives us insight into the changes that have occurred in the last 150+ years, which is important for the understanding of the ecology of the present landscape.

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Funding

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Global Studies 2009

Issue

An educational experience outside the U.S. has become an integral component for today's students in higher education. Several years ago, the National Association of State Universities and Land-Grant Colleges strongly encouraged its member institutions to internationalize their curricula and provide significant international opportunities for students and faculty outside the classroom that would lead to life-long partnerships and cultural awareness. The ability to complete in an international marketplace requires significant understanding of world cultures, politics, trade, economics, and religion. The college years provide the best opportunity for students to gain those experiences through semester and summer study programs and international internships that closely relate to the student's career goals.

Action

The Dale Bumpers College of Agricultural, Food and Life Sciences initiated the Global Studies Program in 1996 to strengthen international education through individually designed study, research, and internship programs to meet the specific career and academic needs of students and to create partnerships with international institutions. Flexibility is the hallmark of this unique study-abroad and internship experience. Each program is planned in advance with the student and their academic adviser to complement the student's interest, research and time availability. Existing study-abroad programs at other universities, institutions and agencies also are carefully reviewed to determine their suitability to the student's academic program. The result has led to participation in study abroad programs offered at other universities as well as specially designed study visits of two to three weeks, carefully crafted summer internships in a country of the student's choice, and a full semester or year abroad.

Impact

Since the inception of the program, the Global Studies Program has placed more than 300 Bumpers College students on study tours, internships, and semester and year abroad programs in 25 countries in Europe, India, China, Central America, Australia, and New Zealand. Prior to the establishment of the Global Studies Program, only one agricultural student a year in the Dale Bumpers College participated in a study abroad experience. During the 2008-2009 academic year, it is projected that 50 students will participate. Students have completed internships at botanical gardens, research in human nutrition and veterinary studies, and study abroad programs in agricultural business, marketing, hospitality, environmental protection, and languages.

The Global Studies Program also has made a significant impact on the academic curriculum. A transatlantic graduate degree in agribusiness was first established in cooperation with the Scottish Agricultural College and has now been extended to include study and research at the University of Ghent in Belgium.

Several new graduate degree programs in agricultural economics and rural development have been established with universities in Austria, Belgium, France, Germany, Italy, Slovakia, and Spain. A community development project is now in its third year in Belize and a study abroad and internship program has been established in Brazil.

Educational study and research links in hospitality and nutrition and veterinary sciences have been arranged with Napier University Queen Margaret University and the Royal School for Veterinary Studies, respectively, in Edinburgh. To internationalize the curriculum in the Dale Bumpers College, a minor in Global Agriculture, Food and Life Sciences now provides students with a global dimension to their undergraduate education and advanced preparation for study abroad activities. It is one of the fastest growing minors in the College.

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Cooperators

Scotland's National College for Food, Land and Environmental Sciences; Napier University, Edinburgh; Royal School for Veterinary Studies; Royal Botanic Gardens, Edinburgh; University of Ghent (Belgium); University of Graz (Austria); and the National Polytechnic Institute of Toulouse (France)

Funding

Endowed Scholarships; Honors College Study Abroad Grants; departmental scholarships and state appropriated funds; Dale Bumpers College of Agricultural, Food and Life Sciences, University of Arkansas; Division of Agriculture, University of Arkansas System

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 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 almost non-existent follow-up care in the home. Prosthetic limbs typical 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 the needs of their patients in a sustainable way, there is a need for prosthetic components that can be manufactured locally in developing countries

Action

Three University of Arkansas biological engineering senior design teams focused in 2007-2008 on the design of low-cost prosthetic devices for use in developing countries. One team designed and implemented a fiberglass molded prosthetic foot that could be manufactured for less than $50. A second team designed and implemented a single-axis prosthetic knee using the material Delrin and stainless steel bolts. The third team designed and implemented a fatigue testing machine capable of applying repetitive loading to prosthetic components to verify fatigue strength. Students did the research, considered multiple alternatives, and used engineering methods to optimize the best solutions. The second semester of the course sequence allowed students to build and test prototypes of their designs. A team of 4 students and 1 faculty presented ideas to a prosthetic clinic in the Dominican Republic. The students got feedback and suggestions from a local prosthetist and worked with the international medical group Physicians for Peace.

Impact

Biological engineering students are learning to incorporate biology and engineering to solve problems in the medical field. Prototypes designed, fabricated, and tested by student design teams in their senior design course provide evidence that graduates of the program will make contributions to improve medicine, health, and quality of life as professional engineers. Students in Arkansas—who have an interest in engineering, biology, and serving people—have an accredited engineering program at the University of Arkansas 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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Funding

College of Engineering; Division of Agriculture, University of Arkansas System; Dale Bumpers College of Agricultural, Food and Life Sciences

Learning agricultural communication industry practices through hands-on coursework

Issue

The field of agricultural communications continues to expand and broaden requiring graduates to possess skill-sets and competencies to meet industry needs. When preparing students for industry positions, it is often a balancing act to be able to teach them the knowledge necessary to be successful while providing them opportunities for real-life practical application. Agricultural communications professionals work with clients to identify and target a specific audience, then develop and disseminate effective messages based on specific strategies and communications tactics in an effort to meet client-driven goals and objectives, and this process must be completed while adhering to budget and constantly using feedback and evaluation methods to ensure success. Agricultural communications students must have the ability to plan, development and administer effective communication campaigns while working one-on-one with a client.

Action

Practical experience working in teams with a client to develop a holistic communications campaign guided the Communication Campaigns in Agriculture course offered in fall 2008 at the University of Arkansas. This course was designed to help students develop understanding of the principles, practices, and applications of social marketing, integrated marketing communications, advertising, and public relations as they pertain to developing communication campaign strategies for the agricultural industry. Students developed a communication campaign for an agricultural company and/or entity focused on a specific product or service. At the beginning of the semester, students formed agency teams – essentially "mini-agencies" – that worked together to develop the major components of a campaign. Because this class was offered to graduate and undergraduate students, graduate students served as project directors for an undergraduate campaign team. These students were responsible for managing their team (agency) and maintaining an effective and efficient working environment. Graduate students acted as the mouthpiece for the agency and served as the primary channel between their team and the client. The class was structured so that each team was working with a different client. Students identified an agency name and created letterhead to use when sending messages to clients. Throughout the semester, the project directors remained in contact with their clients, briefing them on campaign advancements and seeking continuous feedback.

During the semester, students put into practice what was learned in class as they developed their client-centered campaign. The student agencies developed a communication campaign that adhered to a pre-defined structure and had the goal of involving everyone on the team equally in terms of their contribution. The campaign was produced in the form of a formal plans book, professionally formatted and laid out to include required elements. Situation analysis, research report, three-tiered budget, objectives, strategies and tactics report, campaign timeline, media plan (channels, message and media targets), creative elements (seven communication pieces that consisted of letterhead [with campaign theme and logo], print news release, audio news release script, print advertisement, brochure, Web site and one additional communication piece that met goal(s) of campaign), and evaluation plan were all part of the plans book. The plans book included all the pre-mentioned materials in print and electronic form. At the end of the semester, each student agency completed a formal 30-minute presen-

tation to their client using a timed PowerPoint show 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 two 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 participated in leadership positions as project directors and undergraduates were able to work together to create all the necessary components in a campaign. This course will be offered in the future as a senior-level capstone course in agricultural communications.

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Funding
Division of Agriculture, University of Arkansas System

Networks of communication between College of Agriculture students

Issue

Students can readily access information and communicate with their peers through various formal and informal means. These student interactions can aid in knowledge acquisition using communication methods for which physical proximity to their peers is non-essential. Social network analysis focuses on understanding the nature and consequences of links or ties between individuals and/or groups. Investigating early conceptions and use of new media and technology can provide insights about the social environment taking place in the learning environment.

Action

Data were collected at the beginning of the semester from all registered students in an introductory course in the Dale Bumpers College of Agricultural, Food and Life Sciences (fall 2008). A second data collection cycle was completed at the end of the semester (fall 2008). A researcher-developed instrument was used to assess interaction between students and self-reported technology skills.

Impact

Students in this sample population interacted infrequently with their peers in this study. Because of the large scale of this class, students being predominately incoming freshmen to the University of Arkansas, and it serving as an introductory class to departmental majors, these infrequent occurrences are to be expected. Through the data and the nature of the data collection process, many small groups (networks) were observed. Text messaging and Facebook® were common methods used to communicate with other classmates. Most common purposes seen for communicating with peers enrolled were to socialize and vent. It is interesting to note that 12 students did not interact with any student enrolled in this study. Self-reported data were collected on technology proficiency. Average respondent data revealed they felt they possessed average technology skills, would access class materials electronically, and would help others gain access to class materials. An initial implication is that small learning communities within the class would help to involve all students in the learning and social patterns of the class.

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Funding
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General Agriculture master's degree for non-traditional Arkansas students

Issue

The Dale Bumpers College of Agricultural, Food and Life Sciences (DBCAFLS) offers a General Agriculture non-thesis master's degree program that is focused primarily toward "non-traditional" citizens of the state who wish to pursue an advanced degree but are not able to conduct this work in residence on the Fayetteville campus. A clientele group that heavily relies on the accessibility of quality graduate level courses is county extension agents and high school teachers who wish to obtain an advanced degree. Course offerings that are compressed interactive video (CIV) or web-based have been developed and are being used effectively in some disciplines; however, a major obstacle to expansion and adaptation of our plant pathology course offerings for off-campus students has been the lack of a mechanism for hands-on laboratory instruction.

Action

In cooperation with R.D. Cartwright, a new course, Advanced Plant Disease Management (PLPA 4304), was developed for delivery via the Internet. This course was approved by the DBCFLS Curriculum Committee and was taught for the first time in spring 2008. PLPA 4304 utilizes interactive "real-time voice over the internet" lectures weekly (3 h) and includes four all-day Saturday laboratory instruction sessions at the Lonoke Agricultural Center. This is the second plant pathology course to be offered via distance education and the first course in the department to be offered as a Web-based course.

Impact

The motto of the Division of Agriculture is, "Arkansas is Our Campus." The development of quality graduate courses that are accessible to Arkansans outside the Fayetteville campus community has extended plant pathology to students throughout the entire state. Our initial enrollment consisted of 5 students located in different areas of the state and one student from the Fayetteville campus. The availability of the

course opens new opportunities for Arkansans who want to continue their education beyond the undergraduate level, and it provides a link statewide to our department.

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Funding

Division of Agriculture, University of Arkansas System

Youth livestock camp enhances recruiting opportunities

Issue

We need to provide potential students with a tie that will strengthen their interest in attending the University of Arkansas. An activity that will give students a broad-based spectrum of the university and a potential field of study will greatly enhance their decision process as high school graduation approaches.

Action

The Animal Science Department sponsors a Summer Youth Livestock Judging Camp. This summer camp is divided into three days for sheep, cattle, and swine and students are given the opportunity to sharpen communication skills through oral presentations.

Impact

Camp participants gain an understanding of university life through their stay on campus. Students are provided room and board at one of our dormitories and a tour of the Dale Bumpers College of Agricultural, Food and Life Sciences. Participants also learn, first hand, of the objectives and management practices of our school farms.

During the Livestock Judging Camp, participants gain practical knowledge and experience and gain confidence in vital areas such as organizational ability, self-discipline, communication, teamwork, and decision making. Many students for the first time find out what they can accomplish when they work to their potential.

This year marks the tenth year the Animal Science Department has sponsored this camp. Many students will return as they work through the different levels of camp. These students are introduced to former livestock-judging team members, graduate students, and Department of Animal Science professors who help make this camp successful. This program has a great impact on recruiting students and strengthens the bonds with the University of Arkansas Animal Science Program.

Contact

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Funding

Division of Agriculture, University of Arkansas System

REU Site: Assessment and sustainable management of ecosystem services

Issue

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

Action

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

Impact

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

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Funding

Division of Agriculture, University of Arkansas System

Incorporating concrete, experiential learning techniques into an event management course

Issue

Hospitality management is an applied field that requires students to incorporate concrete experience and active experimentation in developing the competencies needed among hospitality society-ready graduates. Students in this field can improve their learning experience if the learning styles include "hands-on" experience. Program evaluations and literature have revealed that students in this field take pleasure in carrying out plans and involving themselves in new and challenging experiences. Yet, because of inadequate resources and the lack of "hands-on" training opportunities, many hospitality management students preparing to secure a career in meetings, events, and convention management are not developing the competencies and confidence needed in event planning and implementation.

Action

Multiple teaching styles including lecture, guests presentation, group work and discussion, case analysis, service-learning, and real-life "hands-on" projects were integrated into the HESC 4643 (Meetings, Events, and Convention Management) course at the University of Arkansas. The "hands-on" real life project is the planning and implementation of the city of Fayetteville's 15th Annual Lights of the Ozarks Parade, and the planning and implementation of the city of Fayetteville's 1st Annual Pet Parade. The class instructor prepared the students as vigorously as possible for these tasks and divided the students into various committees for the planning and implementation processes. Upon completion of these projects, students submitted a reflection paper regarding their learning experiences in the course. In addition, students were asked about the extent to which the real life "hands-on" event planning experience was effective in increasing their knowledge and skills in event planning. The reflection paper indicated that students' knowledge and skills in event planning prior to the course was generally weak and inadequate. However, after participating in the real life "hands-on" event planning project, the students' reflection paper indicated an unprecedented improvement in the students' knowledge and skills as regards event planning and implementation, and a significant improvement in the students' confidence to plan events.

Impact

Students that completed the course (HESC 4643) are more confident and knowledgeable about event planning. Most of these students are preparing for professional employment as event planners, event coordinators, hotel or restaurant managers, or any entry-level management position in the hospitality industry. The experiences provided in the course have elevated their competencies and better prepared them for these roles.

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Funding

Fayetteville area local businesses; Fayetteville Advertising and Promotion Commission; Division of Agriculture, University of Arkansas System

Teaching effectiveness in Generation Y students' era

Issue

Past studies identified many teaching behaviors that are highly associated with student achievement. The results of these studies indicated that these teaching behaviors (clarity, variability, enthusiasm, task-oriented/business-like behavior, student opportunity to learn, positive reinforcement, avoiding criticism, use of structuring comments, effective questioning, probing) are highly effective for student learning. Other background variables purported to influence student evaluations of teaching effectiveness include the characteristics of the course itself, the characteristics of the instructor, and the characteristics of students. Many instructors employ various teaching behaviors that students of previous generations found effective for learning. The relevance of those behaviors on the learning experiences of Generation Y students, whose manners and interest greatly differs from the previous generations, is uncertain. Hence, the purpose of this study was to examine the factors that influence student learning from the perception of Generation Y students. Generation Y generally refers to persons born between the mid-1970s and late 1990s or early 2000s.

Action

The investigator examined the teaching effectiveness behaviors that influence Generation Y students' learning at the University of Arkansas. The results of the study indicated that the behaviors that students of previous generations found effective for learning were also applicable to Generation Y students. The teaching behaviors include clarity, variability, enthusiasm, task-oriented/business-like behavior, student opportunity to learn, positive reinforcement, avoiding criticism, use of structuring comments, effective questioning, probing, and the level of course difficulty; however, the Generation Y students in the study highly appreciate instructors that combine great teaching skills with great personality, appropriate workload, flexibility, and remarkable friendliness.

Impact

The three most highly rated teaching behaviors that influence Generation Y students' learning include clarity, avoiding criticism, and providing student opportunity to learn. To ensure clarity, instructors should often give a preliminary outline of a lecture at the start of class, outline major points during the presentation, speak clearly, repeat and simplify difficult materials. To ensure that instructors are not putting their students down, they should allow students to freely express and explain their own views in class, students' questions or comments should be respected, instructors should employ and respect constructive criticism in class, and suggest specific ways students can improve. Instructors could ensure that they are providing students opportunity to learn by using easy-to-follow outlines to present class objectives, by being actively helpful when students have problems, by providing helpful explanations and comments, motivating students to come to all lectures, and providing examples that match the class objectives. The study also indicated that instructors that combine great teaching skills with great personality, appropriate workload, flexibility, and remarkable friendliness are highly favored by students' evaluation.

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Funding
George Washington Carver Research Program; Division of Agriculture, University of Arkansas System

Impact of computer and technological skills on millennial generation college students

Issue

Students come to college with computer and technological skills. The Millennials, the generation born after 1982, have been given the additional label of the Net Generation due to their technological savvy. The concern is that there has been an over generalization of this perceived computer confidence and knowledge to all students in this generation.

Action

A study was conducted to investigate college students' technical and social technology competencies based upon their attitudes toward computers and their perception of technical computer knowledge. The participants for this investigation were college undergraduates majoring in apparel merchandising, design, and other majors at the University of Arkansas. The survey design method was utilized using modified versions of The Computer Attitude Scale (CAS) developed by Loyd and Gessler (1984) and The Computer Self-Efficacy Scale (CSE) developed by Murphy, Coover and Owen (1989). A total of 1270 students responded to the survey with 1052 usable surveys constituting an 83% response rate. Frequency and percentage distributions were applied to the data using means, median, percentages, and standard deviations for demographics of age, gender, ethnicity, class standing, and academic major. Individual and group means were compared using independent samples t-tests for gender and ethnicity and one-way independent analysis of variance (ANOVA) tests for the variables of age, academic major, and class standing. Significance was assessed using Tukey's HSD post hoc test. Significant effects were found for social aptitude by age and major and technical aptitude by major. Over 25 were significantly different from ages 18 to 25. Agriculture majors were significantly different from Apparel and Business majors. Males had significantly higher perceptions of technical aptitude, and both social and technical attitude toward computer technology than females. Whites had significantly higher perceptions of social aptitude toward computer technology than nonwhites. Class standing had no significant effect.

Impact

The impact of the perception that all college students are technologically skilled, both socially and technically, affects not only the students' ability to perform in the classroom, but the instructor's ability to teach. Net Generation students (ages 18-25) are different from students over 25, regardless of their class standing. Social technology has become a way of life for current and most likely future generations. Colleges, universities and industry are taking advantage of social technology for recruitment, in the classroom, and on the job. With the use of social technology in business and industry, education should be incorporating it into the curriculum. Implications for practice include technology preparation and readiness assessment for students entering college as well as continued preparation in the secondary arena. Additional research is needed to incorporate industry perceptions of social and technical technology.

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Cooperators
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Funding
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2008 Publications of the Arkansas Agricultural Experiment Station

•DISCOVERY: The Student Journal of the Dale Bumpers College of Agricultural, Food and Life Sciences, Vol. 9
•Good Agricultural and Handling Practices for Grapes and Other Fresh Produce
•Choosing and Using a Co-Packer
•Arkansas Turfgrass Report 2008
•Arkansas Small-Grain Cultivar Performance Tests 2007-2008
•Arkansas Corn and Grain Sorghum Performance Tests 2008
•Arkansas Soybean Performance Tests 2008
•Arkansas Cotton Variety Test 2008
•Animal Science Department Report 2008
•Wayne E. Sabbe Arkansas Soil Fertility Studies 2007
•B.R. Wells Rice Research Studies 2007
•Summaries of Arkansas Cotton Research 2007

Other selected publications of the Arkansas Agricultural Experiment Station

•A Century of Research: Centennial History of the Arkansas Agricultural Experiment Station 1888 - 1988
•History of the Bumpers College: Evolution of Education in the Agricultural, Food and Life Sciences in Arkansas
•Arkansas Global Rice Model: International Baseline Projections for 2000-2010
•COTMAN Crop Management System Manual
•Soils of Jackson County, Arkansas
•Soils of Clay County, Arkansas
•Soils of Desha County, Arkansas
•Soils of Mississippi County, Arkansas
•Soils of Arkansas County, Arkansas
•Sequencing of Vineyard Activities

Index

Conversions for commonly used units

1 ft = 0.30 meters = 30 cm
1 inch = 2.54 cm = 25.4 mm
1 ounce = 28.3 g
1 lb. = 0.454 kg = 454 g
1 PSI = 6.9 kPa
1 ppm = 1 mg / kg
1 gallon / acre = 9.35 L / ha
1 lb / 1000 ft^2 = 4.9 g / m^2
1 lb / 1000 ft^2 = 48.8 kg / ha
1 lb / 1000 ft^2 = 43.56 lb. / acre
1 lb / acre = 1.12 kg / ha
1 bushel / 1000 ft^2 = 3.8 m^3 / ha
°F = (9/5*°C) + 32
°C = 5/9 * (°F-32)


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