



1 9 9 0  
A N N U A L R E P O R T

A L A B A M A  
A G R I C U L T U R A L  
E X P E R I M E N T  
S T A T I O N  
A U B U R N U N I V E R S I T Y





#### ADMINISTRATIVE OFFICERS

James E. Martin, President

Paul F. Parks, Vice President for Research

Lowell T. Frobish, Director

David H. Teem, Associate Director

Russell B. Muntifering, Associate Director

Charles W. Bruce, Assistant Director

R. E. Stevenson, Assistant Director

*The information contained herein is available to all regardless of race, color, sex, or national origin.*

This report was produced by the Office of Research Information

R.E. Stevenson, Editor and Assistant Director

J.R. Roberson, Associate Editor

C.L. Smith, Associate Editor

T.E. Rodriguez, Art Designer

# CONTENTS

FOREWORD	4
EXPERIMENT STATION RESEARCH WAS UNDER THE SPOTLIGHT IN 1990	5
PRODUCERS AND CONSUMERS BENEFIT FROM 1990 EXPERIMENT STATION RESEARCH	10
OUTLYING RESEARCH UNITS PROVIDE DIVERSITY FOR RESEARCHERS	24
REPORT OF REVENUES	25
DIRECTOR'S RESEARCH AWARD	26



Visitors tour wetlands project at the Sand Mountain Substation in Crossville.

On the cover... Vegetable production is increasing in the State, as Alabama growers seek alternatives to marginally profitable row crops. The use of plastics, as shown here in plots at the E.V. Smith Research Center, has proven valuable in production and in providing marketing flexibility for vegetable crops.

# FOREWORD

The new year will be filled with many challenges and opportunities for each of us. Just the number of the year, 1991, is interesting — whether reading forward or backward, it is the same. We can read from right to left and look backward to the security of the past or left to right and see the challenges of tomorrow. Sometimes, looking back to past program goals, decisions, or accomplishments helps to define the route for the future.

In the 1988 Annual Report of the Alabama Agricultural Experiment Station (AAES), the establishment of a Task Force was discussed. The Task Force was challenged to look at Alabama's agriculture, forestry, and related agribusiness industries and to help the AAES to establish a research program to enhance the profitability and sustainability of these industries in the future. It is evident that agriculture, forestry, and related agribusiness are important to the future development of the State's economy. The Task Force's final report will be available in early 1991, but enough information has already been gleaned to initiate the development of specific research programs.

Also in the 1988 report, renovation and construction of new facilities were discussed. In late 1990, construction of a new greenhouse complex was started. The old greenhouses will be removed and a Life Sciences Building erected in their place. This will be a modern facility to enhance the biotechnology effort in the Colleges/Schools of Agriculture, Sciences and Mathematics, and Forestry. Poultry facilities have been renovated to provide the necessary environment for much needed poultry disease research. In addition, the continued development of the poultry facilities has provided Alabama with the best poultry research facilities in the Southern Region. Faculty have used their ingenuity to increase the utilization of crowded space in research on various agricultural problems.

Still needed, however, is a new Animal and Poultry Science Building and a Forestry Complex to provide space for current and future needs. Renovation is needed to provide modern and safe research facilities, to enhance programs in plant physiology and growth, integrated pest management, biological control, food science/safety, fish production and disease, and many other important areas.



Lowell T. Frobish,  
Director AAES

Programs have been developed and implemented that will provide direction for the future. This report highlights but a few of the important research findings of the past year. Some of the results have immediate application, whereas others lay the foundation for future developments. The diversity of AAES programs is evident.

Enough for the past — what will agriculture be like in the next century, which is less than 10 years away? The shift from government-owned and controlled production systems to a free market and global economy in socialistic nations will greatly

impact world agribusiness. As the world population continues to grow, demand for food will increase, particularly in the developing third world countries until their agricultural productivity becomes more sustainable. Global demands as well as U.S. consumer attitudes will impact production in the United States. People have dreamed of visiting and living in outer space for years. Development of lunar bases provides new opportunities for scientific investigation of the moon and its environment, to use the materials of the moon for beneficial purposes, and to conduct research and development leading to a self-sufficient and self-supporting lunar base.

Environmental quality issues will continue to be at the front of everyone's list of concerns. Proper waste management is needed, else further development of livestock, poultry, and fish production will be constrained. Alabama currently has few restrictions on water use and discharge in agricultural production. However, increased awareness about water quality factors and competition for water use between industries and consumers will likely result in new restrictions on water usage and effluent release.

These are but a few of the many opportunities available to us in the future. Scientists, producers, legislators, and other citizens will accept the challenges presented and continue their team effort to address the challenges beyond 1991!

# EXPERIMENT STATION RESEARCH WAS UNDER THE SPOTLIGHT IN 1990

Each year research results from the Alabama Agricultural Experiment Station are reported in a number of outlets. A system of publications dating back to the 1880's provides detailed results of various research projects. Crop updates and variety reports give more timely information on specific crops. A long-established system of reporting in general farm and crop specific magazines and in weekly and daily newspapers in the State keeps Experiment Station research constantly in the news in both rural and urban areas of the State and region.

The Experiment Station, because of the new and innovative work done by researchers at Auburn University, is often in the national news. However, 1990 was a special year — one in which several Experiment Station projects made national and international news. In addition to State and national television, newspapers, and magazines, Experiment Station research was shown on West German television, the British Broadcasting Company, Canadian Broadcasting Company, Finnish television, and the Cable News Network and reported in *USA Today*, the *Wall Street Journal*, and the *London Times*.

## GLOWING BROCCOLI IS REALLY CABBAGE, BUT BIOGENETICS RESEARCH GETS ATTENTION

In April of 1990, researchers conducted a field test at the E.V. Smith Research Center



Micro-injection of genetically altered bacteria into cabbage plants at the E.V. Smith Research Center in Shorter and (inset) movement of the bacteria within the cabbage plant.

near Shorter. In this test, researchers injected cabbage plants with *Xanthomonas* bacteria that were genetically altered to contain a light producing gene from a small fish found in the Pacific Ocean.

The bacteria, which is technically known as *Xanthomonas capestis* pv *capestri*, causes black rot in cabbage, cauliflower, and other related vegetable crops. The bacteria occurs commonly in Alabama and through-

out the United States, but does not cause disease problems in any other crops. Researchers pointed out that the bacteria is not aggressive in nature, and noted that in greenhouse studies, it was difficult to infect plants with the recombinant version of *Xanthomonas*.

The gene donor in the recombinant virus was *Vibrio fischeri*, which is found in certain small marine fish. These fish contain a light producing

*lux* gene, which functions much like lightning bugs or fireflies do. Since this type light is not common in the soil, when it occurs, it allows scientists to easily track it in either plants or the soil.

The research team, which included horticulturists, plant pathologists, and microbiologists, successfully tracked the movement and spread of black rot in cabbage. Perhaps more importantly, this recombinant bacterial gene is being used as a model for studying other biocontrol agents. The successful monitoring of a disease as it progresses through a plant is the first step in developing biocontrol agents that will augment chemical fungicides now used to control these diseases.

In the actual field test, cabbage plants carrying the recombinant *Xanthomonas* genes were placed in 12 X 12-foot plots in mid-April. Though the actual microspray and direct injection of the cabbage plants was conducted in solitude, the subsequent reenactment for TV crews from Montgomery, Columbus, and later CNN probably makes this 12 X 12-foot plot of soil and these cabbage plants the most widely publicized in the world.

The glowing cabbage was erroneously reported to be "glowing broccoli." Its publication in the *Houston Chronicle* caught the eye of a West German television producer, who took video shot by the Department of Research Information and included it into a news clip seen throughout Europe. By virtue of worldwide transmission of the Cable News Network, news of the "glowing cabbage" was seen as far away as Saudi Arabia.

## BLUE AND ORANGE CRAYFISH LOOK, TASTE LIKE LOBSTER

Auburn researchers are evaluating a crayfish that grows to about a quarter of a pound in about 6 months in Alabama ponds, survives well on bermudagrass hay, and tastes like a Maine lobster. The crayfish, usually referred to by its native Australian name, redclaw, isn't very red at all. In fact, it is orange and blue, and when held for a few hours in clear water, it is a brilliant orange and blue.

Redclaw has enough going for it as a seafood delicacy that it doesn't need the Auburn

color gimmick to generate additional attention. However, in Alabama the orange and blue lobster was a natural for the media. The better news is that it could become a natural for Alabama producers and consumers.

An Auburn researcher found redclaw during a recent trip to Australia. In winter testing, an entire crop died on December 7, 1989, in ponds at Auburn. In inside aquariums in the winter, Auburn researchers found that redclaw's reproduction can be controlled — a major hurdle in commercial production.

While redclaw could likely survive in Alabama from early April until late October, the first crop was not placed into ponds until early June. At lower stocking rates, these animals grew from less than a half ounce and less than an inch long to over 6 inches long and 3 ounces by late September. At stocking rates of up to 50,000 redclaw per acre, Auburn ponds are expected to produce up to 3,000 pounds per acre. At stocking rates of 10,000 to 20,000, redclaw grow to a larger, probably more marketable, size.

In taste tests at Auburn, redclaw was compared with Maine lobster, Florida lobster, freshwater shrimp, and marine shrimp. In independent testing, it was compared with 18 other seafood products. In the Auburn test, redclaw and Maine lobster were tied for the top rating in taste and texture. In the independent testing, it ranked third in taste, texture, and ease of preparation.

## LOW FAT BEEF AND MCDONALD'S BRING WORLDWIDE ATTENTION TO AUBURN

The development of AU Lean hamburger is one of many beef and pork products developed by AAES researchers in the past 20 years. However, the tie-in with McDonald's and millions of health conscious consumers worldwide created a publicity bonanza for Auburn.

Though working for many years to develop low fat and other restructured beef and pork products, much of the information on the reduced fat ground beef had not been reported publicly. The publication of Alabama Agricultural Experiment Station Bulletin 606, "Advances in Lean Ground Beef Production," created quite a stir among the fast food kings. The publication, already in its second printing, continues to create

interest worldwide in the Auburn-developed product.

Then, in the AU football program for the Florida State game, a story on the lean ground beef product explained some of the research findings. Subsequent sporadic news stories galvanized McDonald's into action, and the result was the Auburn-developed McLean Deluxe®, first test marketed in 22 McDonald's restaurants in Harrisburg, Pennsylvania, in early December. As a result, Auburn researchers were seen and quoted in *USA Today* and the *Wall Street Journal*, and seen statewide via video shot in their lab and transmitted via satellite to television stations throughout the State.

Human nutrition researchers and ag economists made the Auburn study a team effort. Surveys conducted by ag economists at Auburn showed a strong interest among consumers for low fat hamburger products. Human nutritionists confirmed that the Auburn-developed product does indeed offer superior nutrition standards to more traditional ground beef products.

Typically, ground beef at retail stores contains between 20 and 30 percent fat. Ground beef used by fast food restaurants typically contains 20-25 percent fat. For many health-conscious consumers, this is not acceptable. For hamburger connoisseurs, the alternative — less flavorful beef — is also unacceptable.



A taste panel, including Auburn University President James E. Martin (far right), tests McLean Deluxe hamburgers.

Since Americans consume about 3 million pounds of ground beef annually, and this makes up nearly 45 percent of the beef consumed in this country, researchers reasoned there had to be a happy medium between health and taste. After screening hundreds of potential additives, the research team hit upon the ideal ingredients — the so called "magic bullets." By removing over 90 percent of the fat in ground beef, then adding carrageenan and certain hydrolyzed vegetable proteins, the researchers were able to produce a low fat ground beef product with the one previously missing ingredient — taste.

In taste tests at Auburn, the low fat burgers

consistently outperformed hamburgers containing 20-30 percent fat. If the reception by consumers in the McDonald's test market is a good indicator, McLean Deluxe and other similar low fat products are here to stay.

## OZONE, NOT ACID RAIN, IS MAIN THREAT TO SOUTHERN FORESTS

Acid rain and ozone are both aerial pollutants that cause widespread environmental problems. They have been implicated as causes of a gradual decline in growth of pine trees in the South. The dire economic potential of such a slowdown insures state, regional, and national interest.

The economic importance, environmental implications, and the unique "look" of the plastic village constructed on the south side of campus have kept the so-called acid rain project frequently in the news. The conclusion of the first phase of the study naturally generated a great deal of interest.

It is documented that acid rain causes widespread tree kills, and by getting into the food chain via lakes and streams, affects wildlife in the Northeastern United States and in Europe. Speculation has been that acid rain is causing similar, though less spectacular, reduction in pine tree growth in

the South. Since pine trees are the single largest cash crop in Alabama and since the South produces over 50 percent of the nation's timber, such a slowdown could cost the State millions of dollars annually and the region billions of dollars.

The Auburn research team determined that ozone, not acid rain, is a more immediate threat to Southern pine forests. The researchers found that genotypes, or families, of pine trees are affected differently by ozone. Annual growth of pine trees sensitive to ozone decreased up to 20 percent, while those not sensitive to the pollutant had no growth reduction. The obvious next step is

to determine which pine families are and which aren't affected by ozone.

At the acid rain level tested at Auburn, the nitrogen content actually slightly improved pine tree growth. However, most Southern soils are deficient in nitrogen and sulfur — major components of acid rain — so this wasn't really unexpected. The bad news from acid rain may come when soils become saturated with these chemicals and lose their ability to absorb, or buffer, nitrogen and sulfur. If this happens, trees and crops in the South would likely be damaged by acid rain.

### POND GROWN OYSTERS COULD BOOST ALABAMA'S SEAFOOD INDUSTRY

Fisheries researchers at the Auburn University Marine Extension and Research Center in Mobile generated a great deal of interest among the State's seafood industry by attempting to raise oysters in an inland pond. Salt water is pumped

into the small pond from nearby Portersville Bay, near Bayou la Batre, and mixed with freshwater from an artesian well.

This first of its kind experiment could provide gulf coast fishermen a new way to harvest an old crop. If successful, pond production would overcome some of the environmental hazards that have rendered many areas of Mobile Bay unfit for oyster harvest. It also would eliminate degradation by natural predators and reduce the chance of disease, compared to oysters grown in the bay.

The first crop of oysters (50,000) was placed (inside narrow mesh bags) in a 1/10-acre pond on April 27, 1990. These oysters were sampled and sized, then placed in larger mesh bags according to size. Initial growth was surprising, as the oysters grew to about 1 inch in diameter in about 6 weeks. Market size is about 3 inches in diameter. Hot weather and other natural causes slowed growth, still researchers expect to grow two crops in 3 years.



Experimental pond used to grow oysters (above) and researchers checking oysters (left) after about 6 weeks of growth.

While oysters have been grown in mesh bags in bays along the Southeastern gulf coast, none have been grown in inland ponds. The oyster pond at Portersville Bay is about 1/4 mile from the water, but water for the pond must be pumped nearly a mile, because water quality nearer the site isn't acceptable.

## LYME DISEASE RESEARCH CENTERS ON TICK VECTORS

Auburn researchers were instrumental in identifying and documenting the first known case of Lyme disease in Alabama in 1986. Though few knew much about the ailment that is transmitted to humans by ticks, news of this first case stirred interest among State and regional media. Subsequent national media attention has created an ongoing interest in the Lyme disease research being conducted by the AAES.

In a cooperative media project with the Alabama Cooperative Extension Service, AAES researchers participated in a live satellite feed to a Huntsville television station. Subsequent canned video feeds to other stations around the State created a new level of awareness of the disease in urban areas of Alabama.

*Borrelia burgdorferi*, the bacterial organism that causes Lyme disease, has been identified by the AAES research team in black legged and lone star ticks. Black legged ticks are closely related to the tick species known to vector Lyme disease in the Northeast. However, the Auburn research indicates that lone star ticks are more likely to attach to humans. Thus, the primary vector to the disease-causing agent in wild animals may be different than the one that transmits the disease to humans.

Many people mistakenly believe that deer play a direct role in vectoring the disease to humans. As part of this research effort, the Auburn research team has sampled tissue from hundreds of deer killed by hunters at State wildlife management areas and has collected over 3,000 adult ticks, but these pose no threat to man. It is the immature, or nymphal, stage of the tick that vectors the disease to humans. Deer are not affected by the disease-causing organism and merely serve as a host for ticks.

## DAIRY CATTLE ODOR MASKING CREATES PEACEFUL COWLOT

It is well documented that dairy cattle herds have a leader or head of the herd. Cows routinely fight for this position in the herd. When cows are returned to the herd or new cows are introduced into the herd, this type behavior can reduce milk production and interfere with reproductive efficiency.

To reduce this stress, researchers sprayed one group of dominant cattle with anise oil before they were introduced into a new herd, while a second group was swapped, but not treated with anise oil. Normally this type cow swapping generates several days of social jostling as the characteristically dominant cows fight for the leadership role. However, aggression in the anise oil-sprayed herd was less than half that of the untreated herd.

Perhaps the most important result of the study was that milk production remained constant in the treated herd for the first 3 days after treatment. In the untreated herd, milk production was reduced up to 1.5 pounds per day.

Simple enough! So simple and practical in fact that the research report even made the ABC nightly news and the Paul Harvey Report. It also was featured on Hard Copy, a weekly news feature show produced by Paramount Studios and distributed nationally on the Fox Network.

# PRODUCERS AND CONSUMERS BENEFIT FROM 1990 EXPERIMENT STATION RESEARCH

## HIGH CRP TREE MORTALITY DUE TO MULTIPLE CAUSES

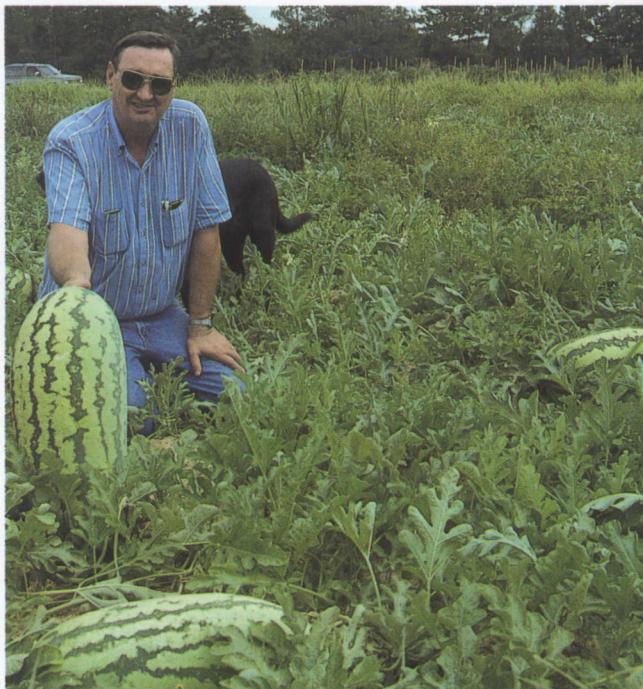
The Conservation Reserve Program resulted in more than 2 million acres of erodible farm land being converted from conventional row crop agriculture to timber production. However, on a reasonably large percentage of the acreage planted (10-15 percent), complete to nearly complete tree mortality was observed. Re-planting these sites resulted in repeated pine failure. Furthermore, no evidence could be found by casual observation as to the agent or agents responsible for this mortality.

Auburn researchers found that root feeding insects, primarily white fringe beetle larvae, in association with nematode-fungal pathogen interactions were largely responsible for the excessive mortality. Researchers also found that these agents were exacerbated by the presence of a well developed plowpan, particularly in years of drought. In addition, it was demonstrated that herbicide residues from past crop production and herbicides used in pine culture to control weeds were not involved in the mortality problems.

This research demonstrated that large regeneration efforts, such as the CRP, can un-

cover significant unforeseen problems that can be solved through research. This is particularly important in light of the massive tree planting programs that are proposed to combat increasing CO<sub>2</sub> levels in the atmosphere and global warming.

## NEW WATERMELONS SUPERIOR TO CURRENT VARIETIES



New watermelon varieties provide marketing flexibility for Alabama growers.

The discovery that plant introduction 189225 was resistant to anthracnose and gummy stem blight led to an Alabama Agricultural Experiment Station watermelon breeding program to develop multiple disease resistant breeding lines that produce high yield of excellent quality fruit. This research led to the development and subsequent varietal release of AU-Producer and AU-Jubilant, which are now grown worldwide.

The new breeding lines being considered for release are AW-82-50-CS – a high quality melon with very dark red flesh – and AW-83-1001-CSY – a high quality melon with yellow flesh. They are superior to current varieties in yield, quality, and disease resistance. Both are distinctly different types of fruits when compared to the current varieties.

## TIMBER HARVESTING EQUIPMENT SHOWS WIDE RANGE OF EFFICIENCY

Timber harvesting research centered on more efficient use of large mechanical harvesting and handling equipment. All of these studies included time, efficiency, and economy of harvest equipment.

The rotary rake is a larger version of a hay rake, consisting of four, 7.5-foot-diameter pinwheels with serrated edges connected to a beam with jump arms. The rake is pulled behind a bulldozer or rubber-tired tractor to take residual material from timber harvesting operations into windrows. Distance, slope in the direction of travel, residual material weight, swath width, and the number of stumps were significantly correlated with time to rake.

The best model to predict raking time included distance and slope and explained 90 percent of the variability in the data. Predicted productivity ranged from 2.6 acres per hour for a 200-foot windrow to 4 acres per hour for an 800-foot windrow. Costs for rotary raking ranged from \$15 to \$29 per acre compared to \$20 to \$40 per acre for conventional raking.

A larger study was conducted over a 2-year period to examine the productivity of one-pass shear and chop, one-pass shear and disc, and shearing and discing operations for site preparation. The three shearing operations were significantly affected by the amount of down and standing residual material, the number and size of the remaining standing stems, stump diameter, and slope in the direction of travel. Discing, which generally follows shearing, was significantly affected by the amount of down residual material and stump number and diameter. Productivity of shearing operations ranged from 1.1 to 4.9 acres per hour depending on the conditions encountered. Productivity for discing operations ranged from 2.2 to 6.0 acres per hour.

The Norcar 600TH harvester and 490 forwarder compose a fully mechanized system for thinning pine plantations. The 600TH can fell, delimb, and cut-to-length (using sensor-input to a microprocessor) approximately two trees per minute. Tree size was the major determinant of productivity. Predicted productivity was a function of tree diameter breast height (dbh), volume, and the number of pieces processed. Productivity ranged from 3 to 35 cords per productive machine hour (PMH) depending on tree size. At an hourly cost of \$100, harvesting cost per cord ranged from

\$35 to \$4 per cord. The 490 forwarder produced about 7 cords per PMH depending on the forwarding distance, the size of the pieces, and the distance between piles. At a cost of \$42 per PMH, the cost for forwarding was \$6 per cord.

## IMPURITIES NOT A PROBLEM IN PHOSPHATE FERTILIZERS

The use of impure phosphate rock can result in the formation of water-insoluble impurities in commercial phosphate fertilizers. There is some concern about the effects that increasing levels of water-insoluble impurity compounds may be having on phosphate fertilizer performance.

A series of field and greenhouse studies was conducted by AAES researchers to evaluate the agronomic performance of triple superphosphate (TSP) fertilizers as related to the level of water-soluble P and metallic impurities. Six commercial TSP fertilizers were collected and evaluated in field and greenhouse tests. The sources were manufactured from the major sources of U.S. phosphate rock (Florida, North Carolina, and Idaho). One source was manufactured from Morocco phosphate rock. Water soluble P among the various TSP fertilizers ranged from 80 to 93 percent.

The commercial fertilizers were shown to be equally effective sources of P and under greenhouse conditions the sources were as effective as reagent grade monocalcium phosphate (100 percent water soluble). Additional studies with TSP type fertilizer materials showed that 90 percent of maximum growth could be obtained when TSP fertilizers contain more than 63 percent water soluble P. Thus, it was concluded that current levels of chemical impurities in commercial TSP fertilizers do not present an agronomic problem.

## SOUTHERN RUNNER PEANUTS LESS AFFECTED BY VIRUS

Research was conducted in 1990 to evaluate the effectiveness of thrips control in reducing tomato spotted wilt virus (TSWV) on several commercial peanut varieties. Aldicarb (Temik) has been the most effective recommended insecticide in controlling thrips which are vectors of TSWV.

TSWV is a relatively new disease on peanuts in Alabama. It was first widely observed in 1986 and has since spread to over 90 percent of peanut fields in the State. Although its incidence within peanut fields in Alabama has been below 3 percent, experiences in Texas and Georgia provide cause for concern about its potential increase.

Although thrips populations were reduced by the insecticide treatment, the incidence of TSWV was not. However, there was approximately 50 percent less TSWV at all locations in Southern Runner peanuts, while GK-7 variety tended to have an intermediate level of TSWV compared to the other two varieties. These data suggest that at-planting insecticides, while providing early season growth of seedling peanuts, do nothing to lower TSWV levels. However, a substantial reduction in TSWV can be achieved using Southern Runner peanut variety.

### LATE-BORN DEER OVERCOME LACK OF SIZE IN SECOND YEAR

White-tailed deer fawns may be born as early as May or as late as November each year in Alabama. Though later born fawns start out at a disadvantage, recent Experiment Station research indicates these deer catch up in size during their second year.

In an AAES study, 25 male fawns were collected at random from throughout Alabama. Birth dates of these fawns ranged from May 20 to September 2. Most were born in August. Body growth and antler development were studied through 24 months of age as part of the Experiment Station's ongoing white-tailed deer research.

Results showed these deer had similar body and antler sizes at 16 months of age if fed optimum diets. By December of their second year there were no significant differences in body weight or antler size regardless of chronological age. Yearling males averaged

weighing 128 pounds, ranging from 111 to 150 pounds. Yearling racks averaged 4.2 points, ranging from 2 to 8.

Yearling males lacking branched antlers and having body weights below about 115 pounds in Alabama should be considered the consequence of inadequate amounts of good quality food, a condition usually associated with having too many deer.

Though later born deer catch up in growth, the wide range of birth dates among white-tailed fawns presents problems for population managers. Most herd condition decisions are made using body weight and antler size related to age. Traditionally, wildlife biologists have lumped all samples into whole year-classes. In actuality, in Alabama and certain other areas of the Southeast, deer within these year-classes may differ in true age by as much as 4-5 months. Hence, body weight variation within the 1 1/2-year class may be related to chronological age as well as nutrition. It is important to evaluate each animal's weight at a given month of age rather than considering them collectively as the same year-class.

Recent Experiment Station research has resulted in the development of an aging key that will allow field biologists to accurately age white-tailed deer by month through about 24 months of age. The key was developed by taking dental impressions of a number of deer of known age each month through 24 months and observing and measuring tooth eruption and growth rates. This accurate aging key will facilitate more accurate herd evaluations and hence more precise management recommendations.



Date of birth and nutrition prove key elements in antler development of young white-tail deer.

### NEW METHOD DEVELOPED TO DETERMINE COTTON BLENDS

Fiber blends of various compositions play an important part in textile and apparel markets. Selection of proper recipes and sequences in chemical processing, particularly dyeing, requires

knowledge of the blend composition. In mechanical processing, quality control of the manufactured products is essential in order to rectify the machine errors in the blending of the fibers. At the market level, the ability to check fiber blend compositions quickly and accurately is of considerable importance and value.

Various methods are used for the analysis of fiber blends. These include measuring moisture regain, scanning electron microscopy, optical attenuation, bundle load-elongation curve analysis, the use of microwave resonators, improved methods of quick chemical analysis, infrared spectrophotometry, and near infrared reflectance spectroscopy.

AAES researchers have developed a straightforward way of using analytical pyrolysis to give an estimate of the blend ratio of textile yarns and fabrics. The method has the advantage of being quick and reproducible.

Although the equipment used for this research is of a specialized and relatively complex nature, the method could be adapted for commercial use on a simple instrument dedicated to this purpose.

Analytical pyrolysis was used to determine blend levels in cotton/polyester yarns. Instead of trying to separate the individual compounds created by pyrolysis, the gas chromatographic conditions were set to move the pyrolyzates quickly through the column, and measurement of the total area of the peaks became simple and reproducible. By pyrolyzing known specimens of pure and blended fibers, a calibration chart and a regression curve were created that allow unknown specimens to be pyrolyzed and their blend ratios to be calculated. The weights of the specimens tested and the areas of the resulting programs are sufficient to give accurate and reproducible results in a short time.

## PATHOGEN-FREE EMBRYOS GOAL OF ANIMAL SCIENTISTS

Embryos collected from cattle within a week of conception resist infections by many pathogens, but surface contaminants could result in infections of embryo recipient cows after transfer. Research in the AAES has contributed to the development of treatments to insure that embryos

for transfer are free of organisms that might stick to the surface of embryos and carry infections to recipient cows.

Recent tests utilized special chemicals synthesized by chemistry researchers at Auburn to disinfect embryos. It is expected that this approach will be effective against a variety of microorganisms, including some that are known to resist other treatments. A universal treatment resulting in specific pathogen-free bovine embryos would allow the salvage of genetic material from cows that are infected with selected diseases, and it would enhance the marketability of this germplasm both nationally and internationally.

## POND BOTTOM MANAGEMENT IMPROVES WATER QUALITY

The quality of water in ponds is affected by the condition of pond bottom soils. In channel catfish ponds, fish are fed year after year and organic matter accumulates in bottom soils. High concentrations of organic matter in pond soils lead to low concentrations of dissolved oxygen at the pond bottom and favor the accumulation of toxic substances such as nitrite and hydrogen sulfide. Recently, Experiment Station research was initiated to develop techniques for lowering organic matter concentrations in pond soils.

Concentrations of organic matter in pond soils were compared after fish harvest in ponds that had been aerated each night for 6 hours and in ponds receiving only occasional emergency aeration throughout the production period. The increase in soil organic matter was 0.60 percent (from 1.44 percent in the spring to 2.04 percent in the fall) in the nightly aerated ponds and 0.96 percent (from 1.53 percent in the spring to 2.49 percent in the fall) in the emergency-aerated ponds.

Several techniques for treating pond bottom soils between fish crops were tested in laboratory-scale experiments. When soils were flooded with 2 inches of water, organic matter concentrations increased over a 9-week period. However, when soils were dried and exposed to the air for 9 weeks, organic matter concentrations decreased by 0.25 percent. Other procedures, such as tilling and liming dry soils, did not appreciably enhance the rate of organic matter decomposition.

Thus, good aeration of ponds during the production cycle and drying of pond bottoms

between crops appear to be a good way of reducing the rate of organic matter accumulation in ponds.

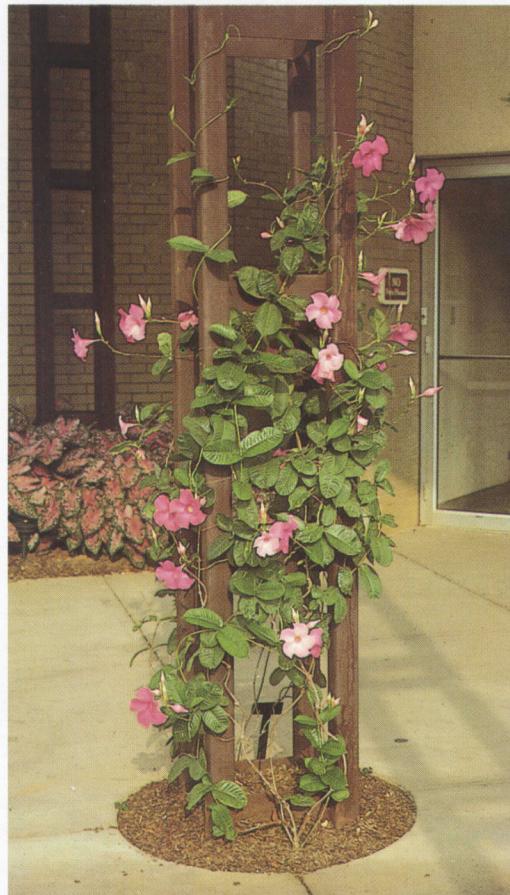
## SUMAGIC WORKS MAGIC ON MANDEVILLA GROWTH

Alice du Pont, the most widely available cultivar of *Mandevilla*, is grown for greenhouse use or as a horticultural annual in temperate areas. This plant blooms over a long season and is useful for arbors, trellises, or other supports about which the stems can twine.

The vigorousness of Alice du Pont creates production problems for the grower since consumers are interested in manageable plants in flower. To produce flowering plants, growers frequently contend with excess vegetative growth that twines around other plants and structures. In research at the AAES, multiple applications of Sumagic, a new triazole growth retardant, effectively suppressed vegetative growth and resulted in compact flowering plants of mandevilla.

In preliminary work, a single application of 30 parts per million (p.p.m.), or higher, of Sumagic retarded growth excessively for at least 6 weeks, after which plants began to exhibit normal growth. All rates of Sumagic induced leaf cupping, delayed flowering, and reduced bloom size.

Single applications of 5, 10, 15, or 20 p.p.m. of Sumagic did not provide acceptable control of internode elongation. With two applications of Sumagic, 5 p.p.m. was inadequate, 10 and 15 p.p.m. were acceptable, and 20 p.p.m. was excessive in controlling shoot elongation. Multiple applications of all tested rates of Sumagic effectively suppressed elongation. As the concentration of Sumagic increased, the interval between applications increased from 28.5 days with 2.5 p.p.m. to 39.5 days with 20 p.p.m..



Growth retardant proves effective in controlling vegetative growth of mandevilla.

Multiple application of Sumagic at rates of 2.5 to 20 p.p.m., reapplied when shoots begin to elongate, is an effective means of controlling excessive vegetative growth of mandevilla and may provide growers with an additional management tool in production of this flowering horticultural annual.

## PHYSICAL ACTIVITY INCREASES VITAMIN C REQUIREMENTS

Vitamin C has several functions within the body, including formation of adrenaline, normal absorption and utilization of iron, normal development of connective tissue, and indirect effects on the body's ability to use fat as an energy source. Vitamin C also seems to be necessary for the normal production and/or release of "stress-related" hormones, such as cortisol, from the adrenal gland.

AAES studies involving animals indicated physical activity significantly reduced the vitamin C content of liver and adrenal gland tissue compared to values obtained in sedentary animals. In addition, exercised animals that received vitamin C at three times the requirement level had plasma cortisol concentrations lower than a similar group of exercised animals receiving the requirement level for vitamin C.

Results of human work indicate reduced cortisol levels and lower exercise heart rates in subjects receiving 600 mg of vitamin C per day (10 times the recommended daily allowance) as opposed to when the same subjects received the recommended 60 mg of vitamin C per day. Findings from all of these studies suggest that dietary vitamin C requirements are increased during periods of strenuous physical activity.

## RECOMBINANT VIRUS GENE USED TO DEVELOP VACCINE FOR CATTLE

AAES researchers have been studying the immune response of cattle to infectious bovine rhinotracheitis virus (IBRV). This virus produces an acute respiratory disease that can lead to fatal pneumonia, especially when it infects newborn calves.

IBRV is a herpesvirus and, like its human counterpart herpes simplex virus, it has proven to be an extremely challenging virus to immunologists. The problem in eliminating IBRV, or other herpes viruses, from a population of animals is that the virus often is able to remain hidden in an animal for a long time until a stressful situation causes it to reappear. It is at this time that the virus can be transmitted to other animals.

The researchers are currently trying to develop a safe and effective vaccine to prevent the disease. One approach is to utilize recombinant gene technology and insert viral genes into a harmless live virus. The animals are vaccinated with the harmless virus and the added viral gene initiates an immune response to protect the animal against the virus from which the inserted genes were obtained.

The approach being used for IBRV is to identify regions on the molecules that are important in inducing protective immunity, chemically synthesizing these areas, and using these as a vaccine.

## SUPERIOR BRANCHING KEY TO HIGH YIELD OF LATE-PLANTED SOYBEANS

Late-planted determinate soybeans usually yield less than soybeans planted at optimal planting dates in the Southeast. This has been attributed to reduced vegetative growth. Developing cultivars with indeterminate growth habit has been proposed as a means of overcoming the lack of vegetative growth in late-planted determinate soybeans. Experiment Station researchers compared two determinate and two indeterminate soybean genotypes in two late-planting dates and two narrow-row spacings to determine the value of the indeterminate growth habit in late-planted cropping systems.

Delaying planting from June to July had a large effect on yield, regardless of growth habit, but affected the determinates (30 percent yield

reduction due to delayed planting) more than the indeterminates (23 percent yield reduction). However, determinates were consistently higher yielding throughout the experiment.

Row spacing, 24 versus 12 inches between rows, had no effect on yield. Parameters most related to yield involved branching ability, such as branches per plant node and branch pods per plant.

Superior branching ability was the most obvious reason for the yield superiority of the determinates. Although the indeterminates were taller and had more main stem nodes per plant, this did not translate into higher yield. Thus, indeterminate growth habit had no advantage in this late-planted, narrow-row cropping system.

## COMPUTER MODELS IMPROVE FOREST NURSERY EFFICIENCY

Forestry researchers, with the overall goal of increasing profitability of woodland operations, made several significant contributions which emphasize cost-reducing measures and consideration of risks.

A linear programming analysis of a case-study industrial forest tree nursery showed that nursery profitability could be increased by decreasing the planting density of seedlings sold to the company and increasing the density of seedlings sold to non-company users.

An analysis was made of the production structure of the U.S. paper and paper board industries. A translog cost function was estimated for the period 1958 to 1985. Own price elasticities showed energy demand to be most responsive to price changes and material demand least responsive. Technological change bias was energy using and labor and material saving.

Models for examining risk-efficiency of rotation age, site preparation, and species-site establishment decisions have been developed. A model for examining risk-efficient planting densities is currently being developed. A model for machinery replacement under risk was developed. Results indicated that when risk is considered, machinery replacement becomes optimal at shorter intervals than in the deterministic case.

A study was conducted to examine the influence of thinning systems (forwarder or

skidder) on stand damage and economic returns from commercially thinned loblolly pine plantations. At low levels of mortality the skidder system resulted in higher economic returns, while at high mortality levels the forwarder system was preferable.

## HYPOTHESIS FOR SPECIFICITY OF INSECT COMMUNICATION

Pheromones, the odors by which insects and other animals communicate over long distances with members of their own species, have become important tools for monitoring and occasionally controlling populations of problematic forest insects. Properly formulated, the synthetic pheromones act like their natural counterparts, attracting only one or a few insect species, possibly including their specialized parasites or predators.

How does pheromone specificity evolve? The commonly accepted hypothesis invokes competition for a private channel of communication among co-occurring species. Experiment Station research on pheromone communication and courtship songs of *Ips* pine bark beetles of the Southern United States challenges this idea. Auburn researchers have developed a new and simplified hypothesis: Specificity in animal communication systems, like those of the bark beetles, may arise as a simple by-product of evolutionary divergence.

Distantly related species of *Ips* pine bark beetles, like the trio of coexisting Southeastern species, are not pheromonally cross-attractive. Even at trees hosting a mixed infestation, males of these three species reliably distinguish among the courtship songs of the different species' females.

However, whether co-occurring or widely separated geographically, genetically closely related species of *Ips* pine bark beetles are attracted to each other's pheromones. And once attracted, males fail to discriminate against the squeaky courtship songs of females of the other species, thus leading to infertile pairings.

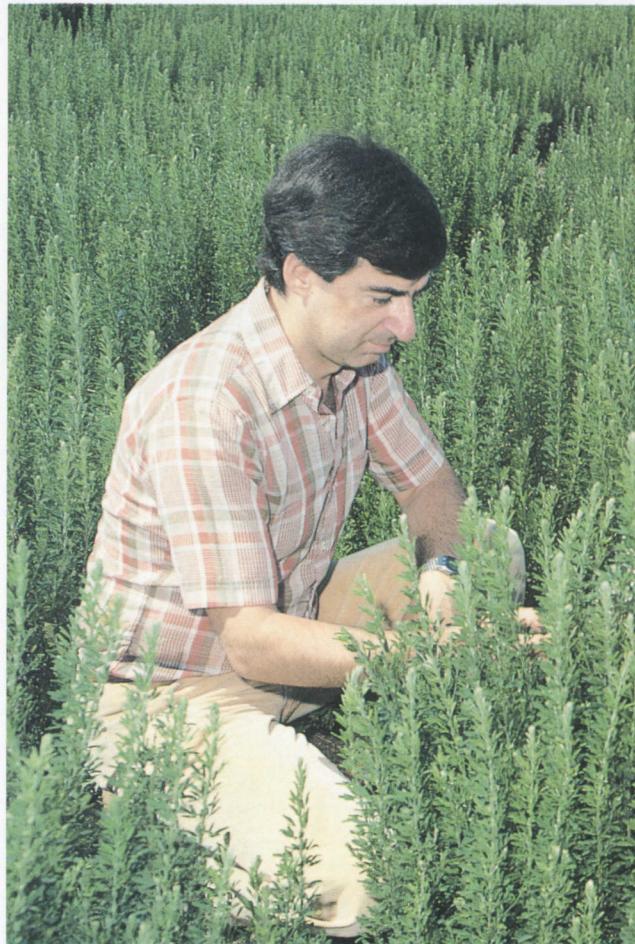
## NITROGEN A LIMITING FACTOR IN SERICEA LESPEDEZA GROWTH

Sericea lespedeza is a long-lived perennial that is used for forage production and soil conservation. Since sericea is dormant during winter, it is desirable to overseed it with winter grasses to extend the productive season. Fertilization of sericea lespedeza and grasses should be at the rate for the grasses grown. Auburn researchers investigated the possibility that sericea lespedeza litter might have an allelopathic effect on the companion grass. Allelopathy refers to inhibitory or stimulatory reciprocal biochemical interactions among plants.

Ryegrass was less affected by sericea lespedeza residues than rye and tall fescue. Germination, emergence, seedling growth, biomass dry weight, and N content were reduced by sericea lespedeza residues in rye and tall fescue.

Although ryegrass was more tolerant to the residues, biomass dry weight and N content were also reduced. Soils in which sericea lespedeza was grown reduced the growth of rye, ryegrass, and tall fescue and lowered ryegrass germination.

Nitrogen was the main factor limiting plant growth. The large effect of N fertilization more than compensated for the negative effects of the residues in all species.



Research demonstrates both the positive and negative effects of sericea lespedeza on subsequent forage crops.

A similar study was conducted with the summer grasses bermudagrass and bahiagrass. Both plant species were found to have a similar response to sericea lespedeza residues. These residues were found to inhibit bermudagrass and bahiagrass growth, but did not affect their seed germination and emergence.

The harmful effects of sericea lespedeza residues are small compared to the effect of N fertilization. Nitrogen increased biomass dry weight and N shoot content. Thus, N was the main factor limiting plant growth.

## WILD RADISH A THREAT TO WHEAT PRODUCTION

Wild radish, a member of the mustard family, is a common and troublesome weed in Alabama wheat fields. Since it grows rapidly and canopies over wheat, it is assumed to be competitive, although the extent is not known. Also, wild radish seed pods break into one-seeded segments and contaminate grain during the harvesting operation. These segments are difficult to remove from the grain. Some reports suggest that wild radish seeds are toxic to animals.

Research was initiated to determine how competitive the weed is with wheat. Wild radish was shown to reduce yield in a 11.6-square-foot area by 28 percent, in 1988-1989, when the weed had an average dry weight of 0.11 pound. This translates into 15 bushels per acre if the potential yield is 50 bushels per acre. The wild radish population would be equivalent to 3,755 plants per acre or one per 2 square yards.

## BLACKBERRY, RASPBERRY VARIETIES BEING TESTED FOR ALABAMA

Pick-your-own berry operations have become increasingly popular in Alabama. Though blackberries remain the most popular, growers and consumers alike have shown much interest in red raspberries. AAES researchers are conducting ongoing tests to find more desirable varieties of both blackberries and raspberries for Alabama growers.

Research was initiated last year to determine if any red raspberry cultivars can be adapted to Alabama's climatic conditions. Twenty-two different raspberry cultivars were planted at the

E.V. Smith Research Center and an extensive background search was conducted to find any new and older forgotten cultivars which might have potential for Alabama. Cultivars with a special ability to produce a fall crop (primocane fruiting), plus the standard summer fruiting cultivars, were included.

Interest in red raspberries is extensive because they are such a high value crop. For example, pick-your-own prices have ranged between \$1.00 and \$1.50 per pound, while wholesale priced fruit can sell for \$1.25 to \$2.00 per half pint. Retail prices in the past have been about \$2.50 per half pint. Potential yields range from 2,000 to 5,000 pounds per acre.

Blackberry cultivars and cultural practices are being evaluated at the Chilton Area Horticultural Substation. New blackberry cultivars have average yields of 8,000 pounds per acre on a commercial basis. Of particular interest is a new thornless blackberry cultivar, Navaho, which requires no trellis system and has excellent flavor. Cultural investigations include mechanical pruning treatments to reduce pruning costs and increase yields.

Blackberries show excellent commercial potential as an alternative to traditional agronomic crops in all areas of Alabama. Potential returns of over \$9,000 per acre make blackberries an attractive enterprise for Alabama farmers.

## ROBOTICS BEING DEVELOPED FOR USE IN NURSERY INDUSTRY

Research is continuing on the adaptation of a SCARA-type robot for robotic transplanting of bedding plants. A robot gripper, incorporating infrared sensing and water application, is being tested using marigold, geranium, and other varieties. The robot system is being evaluated as a component in the mechanization of transplanting seedlings from plug flats to growing flats and pots, a repetitive and monotonous task for humans.

Preliminary results show the robot can transplant 1 seedling in 5 seconds with a success rate of about 90 percent for marigold and geranium seedlings. Further work is planned to increase the speed and success rate, evaluate other varieties, and develop automated handling systems to reliably move flats into and out of the work cell.

## RESERVOIR TILLAGE INCREASES IRRIGATION EFFICIENCY

Experiment Station researchers monitored effects of reservoir tillage and LEPA (low energy precision application) irrigation on water conservation on cotton production. They found that reservoir tillage reduces surface runoff and increases irrigation efficiency.

Reservoir tillage, a method of implanting small reservoirs in crop furrows, retains water that might otherwise be lost as surface runoff.

LEPA increases water use efficiency by providing water to the crop using drop tubes. Water is released approximately 1 foot above the soil surface. Thus, losses caused by wind are reduced with this method.

The energy requirement for the installation of reservoir tillage was between 6.5 and 9.3 kWh per acre, depending on soil compaction and moisture content.

## STUDIES SHOW ALTERNATIVES FOR CATFISH POND EFFLUENT MANAGEMENT

Results of studies on the economics of water quality control in catfish production provide some interesting insights concerning pollution abatement for consideration by Alabama catfish producers.

First, a study completed in late 1989 showed that the configuration of the fish pond system was important in minimizing cost of water quality control. Using dissolved oxygen as the measure parameter in water quality, alternative pond system configurations and water treatment procedures were evaluated via computer simulation.

Combinations of ponds containing at least two different sizes were preferred over pond sys-

tems with only one size. A maximum of 20 acres per pond was considered best when combined with at least one 5-acre pond. The purpose of different sizes was to allow reuse of a smaller production pond as a settling basin for effluents drained from other ponds during fish harvest activities. It is well established that approximately 95 percent of pond waters may be drained into receiving streams prior to harvest without seriously impacting water quality of the stream. The remaining 5 percent of the pond water contains 95 percent of the effluent load.

The most cost effective water treatment procedure other than simple dilution was a constructed marsh filtering system. A marsh filter for a 60-acre pond system was found to cost about \$20 per acre to construct and operate under ideal conditions and acceptable final effluent concentrations (up to 100 milligrams per liter BOD). Alternative systems, such as a sand filter system, cost much more, but are more effective in removing most types of waste.



Dammer Diker used to create in-furrow reservoirs to trap moisture and reduce soil erosion.

per acre as taxes were raised.

On the other hand, an imposed standard would be quite effective in limiting production and effluent discharge. In fact, a restriction on chemical oxygen demand (COD) concentration to 12 milligrams per liter would cut the rate of pro-

duction by 50 percent. Also, such restrictions would tend to force shorter production periods (1 year versus 2), but would yield about the same total fish production over time.

## POULTRY LITTER MOST VALUABLE AS LIVESTOCK FEED

In Alabama, the production of broiler litter is estimated at 2 million tons annually. This represents a sizeable resource that has potential for development and utilization as a feed ingredient, a fertilizer, or for conversion to methane or other products.

An AAES survey of broiler litter composition in Alabama indicates the average composition of litter is 24.9 percent crude protein, 23.6 percent crude fiber, and 24.7 percent ash. Based on the survey results, broiler litter of average composition has an estimated value as a replacement for fertilizer nutrients of \$28 per wet ton of litter. Its value in an 80 percent litter-20 percent ground corn grain diet for beef cattle to replace a diet of corn, Coastal bermudagrass hay, and soybean meal is estimated at \$105 per wet ton of litter, four times the fertilizer value.

However, to be used as livestock feed, litter should be processed to render it safe from pathogens, and to preserve its feed nutrient value for ruminants. A common method of processing litter is by deep stacking. Litter stored in stacks undergoes spontaneous heating which promotes destruction of pathogens.

Although moderate heating may be beneficial, AAES studies indicate excessive heating (over 140°F of stacked litter for long periods of time) can be detrimental to its feed value. Excessive heating causes a decrease in available dietary crude protein through volatilization of ammonia and by heat damage, which reduces the solubility of the remaining crude protein.

To be used as a ruminant feed ingredient, litter should contain at least 18 percent crude protein; less than 25 percent bound nitrogen (BN), and 30 percent ash. Based on these criteria, about 35 percent of the litter produced in Alabama would not be a suitable feed ingredient. Therefore, the value of litter is largely dependent on how it is managed.

Heat damage of litter can be controlled by maintaining litter moisture below 25 percent

and by covering the litter stack with polyethylene to restrict access to air.

Stacks covered with polyethylene achieved lower temperatures (about 112°F) than litter stacks that were not covered (168°F). The covered stacks had less phosphorus bound or insoluble nitrogen (BN), compared to the not covered stack.

Additional AAES studies indicate the effect of excessive heating on litter quality can be significant. The BN content of fresh litter is about 10 to 15 percent of the total nitrogen, but after excessive heating the BN can increase to over 50 percent. As litter nitrogen becomes bound or insoluble, less is available as a source of dietary nitrogen.

## NATURAL RESOURCES ATTRACT TOURIST DOLLARS TO RURAL COUNTIES

Development of depressed rural economies is a major goal of the State of Alabama. One characteristic of most undeveloped rural areas is an abundance of natural resources. Auburn research has shown that these type resources can provide a vital element in economic development if properly managed, developed, and protected.

A strategy for rural development through expansion of the tourism industry (combined with resource protection) was developed in 1990 for Lowndes and Cleburne counties. The basis for that strategy is organization within the county to combine private and public initiatives into long-range directions as opposed to immediate period exploitative development. The analysis reviewed the potential for using existing natural resources as a base for expanding visitation to the respective counties. For example, in Lowndes County, the ongoing hunting and fishing industries provide substantial visitation to the county, but nearly all money spent immediately goes to neighboring counties.

Cleburne County, on the other hand, needed a focus on existing opportunities associated with the presence of the Talladega National Forest and the highly popular historical base associated with gold mining. Strategies were developed to include planning for transportation, city-county organizations, public-private joint ventures, development of the services sector, and rural-urban conflicts.

Cleburne County was found to have the potential for increasing its income by \$20 million annually. Lowndes County income projections were somewhat smaller because only a portion of the county was included in the evaluation. Yet, income still could be expected to rise by \$1.0-\$1.5 million annually from expanding only hunting and fishing in the northern sector of the county. Thus, the economic impacts of using natural resources as tourist attractors is significant in rural Alabama counties.

## COMPOSTING PROVES EFFECTIVE FOR DISPOSAL OF POULTRY MORTALITIES

Mortality is a normal component of broiler production. For a flock of 100,000 broilers grown to 49 days of age and averaging 0.1 percent daily mortality (4.9 percent total mortality), approximately 5 tons of farm mortalities require disposal.

Burial pits are commonly used for the disposal of poultry farm mortalities, but the persistence of residues after years of use and the potential for ground water contamination are serious disadvantages. Incineration is one of the biologically safest methods of disposal; however, it is slow, expensive, and may generate air pollution. Thus, identification of alternative methods for the disposal of mortalities is a priority of the poultry industry.

A potential alternative is composting, a natural process by which organic waste material is biotransformed into a more useful end product, in an environmentally and biologically safe procedure. This alternative was evaluated in an AAES study of a commercial on-farm composter that determined changes in microbial populations, temperature, and moisture during a typical composting cycle.

During composting, the population of to-

tal aerobic bacteria remained relatively constant throughout primary and secondary composting. Initially high levels of enteric (coliform) bacteria declined only slightly during primary composting, but were reduced to nondetectable levels once the compost was aerated by transfer to the secondary composting bin. Temperatures in the primary bin increased within 3-5 days to 110-120°F and remained steady until the material was transferred (7-8 days) to the secondary bin. Temperatures in the secondary bin quickly achieved 140-150°F and remained steady over 25 days of composting. Moisture levels varied from 25 to 45 percent.

Coliform bacteria were effectively inactivated during composting, indicating that enteric pathogens (e.g. *Salmonella*) would be inactivated. Results further indicate that aeration due to transfer of compost from the primary to secondary bin is critical for temperature generation and the resultant thermal inactivation of enteric bacteria. Based on this evaluation, composting is an environmentally and microbiologically sound method for the disposal of poultry farm mortalities.



Research demonstrates composting to be an economical and beneficial method of disposing of poultry mortalities.

## TURBINE PUMP HARVESTING PROMISING FOR CATFISH PRODUCERS

Removing fish from production ponds for shipment to processing plants is a slow, expensive, and sometimes dangerous process. For these reasons, research is underway at Auburn to improve fish harvesting procedures.

Three methods of loading market channel catfish (1 to 4 pounds) onto transport trucks were evaluated. A negative-positive pressure pump (pump N-P) and a turbine pump (pump T) were compared with the traditional boom and basket method of loading fish. The loading devices were tested for the rate that fish could be lifted from a concrete holding

tank to a transport tank (10-foot lift) and the trauma caused by the devices during loading from earthen ponds.

Significant differences in average loading rates were found among treatments. Pump T, boom and basket, and pump N-P loaded an average of about 660, 348, and 119 pounds of channel catfish per minute, respectively. Fish mortality due to loading trauma was not different among treatments when fish were placed in earthen ponds and held for 3 weeks after harvest during the summer months. Harvest mortality with the pump T, pump N-P, and boom and basket were 15, 11, and 6 percent, respectively.

Fish mortality was higher using the pump loaders compared to the boom and basket. However, the turbine pump loaded market channel catfish at a rate approximately two times and six times faster than the boom and basket and negative-positive pressure pump, respectively. Preliminary tests indicate that the turbine pump may be more effective at loading fish onto transport tanks than the boom and basket and could have a positive influence on the channel catfish industry.

## OXYGEN PROBLEMS INCREASING FOR ALABAMA RESERVOIRS

AAES researchers, in conjunction with Auburn's Department of Civil Engineering, assessed the ecological conditions of 34 Alabama reservoirs, ranging in size from a few hundred acres to 66,000 acres.

The goals were to document water quality and define the trophic condition of each reservoir in order to better manage and protect Alabama's public waters. This trophic condition refers to relative levels of nutrients and microscopic plant growth in reservoirs. With excess nutrients from point source (e.g. waste treatment effluent) and non-point source run-off (e.g. from fertilized fields and urban areas), reservoirs can become eutrophic. Eutrophic reservoirs exhibit accelerated plant growth, and as these extra plants die and decay, oxygen demand can exceed supply. These low oxygen levels can kill fish and damage the food chain. Taste and odor problems also can result from eutrophication, as well as difficulty in processing potable water.

Most reservoirs in the study had trophic state index values in the 40's and above (scale 0-

100, with each increase of 10 representing a doubling of algal biomass). Lakes that had high TSI values (50's-60's) in a 1985 EPA/ADEM eutrophication study tended to remain high or increased in this 1989 study. Of greater concern, however, were those lakes that had low TSI values during the 1985 study and in 1989 had more than doubled their trophic ranking.

## NEW VITAMIN C SOURCE IMPROVES CATFISH FEEDS

Previous research at the AAES showed that channel catfish, unlike farm animals, are sensitive to a dietary deficiency of vitamin C. L-ascorbic acid is the vitamin C source used in commercial fish feeds, but over 50 percent is lost in processing and storage.

Each source of vitamin C was fed at four dose levels, 11, 22, 44, and 132 parts per million (p.p.m.) for 14 weeks. Fish fed no ascorbic acid (control) and the lower levels of ascorbic acid sulfate grew poorly and showed signs of scurvy (crooked backs). Growth rate and condition of fish fed ascorbic acid phosphate was equal to that of the fish fed L-ascorbic acid, even at the lowest level fed. Higher concentrations of ascorbic acid were found in tissues of fish fed ascorbic acid phosphate than in fish fed L-ascorbic acid which indicates that ascorbic acid phosphate is more available to catfish than L-ascorbic acid.

Regression curves for growth showed that ascorbic acid phosphate has equal vitamin activity to L-ascorbic acid, but ascorbic acid sulfate has only 6 percent of the activity of L-ascorbic acid. Regression of tissue storage of ascorbic acid showed that ascorbic acid phosphate had more (175 percent) vitamin activity and that ascorbic acid sulfate had only 5 percent more than L-ascorbic acid.

## COTTON APHID CONTROL CREATES OTHER INSECT PROBLEMS

Outbreaks of cotton aphids have recently become more frequent and severe in some areas of Alabama. In addition, when outbreaks occurred in 1988 and 1990, they were difficult to control with chemical insecticides.

Concurrent with increased problems with cotton aphids, tobacco budworms developed high levels of resistance to pyrethroid insecticides in Texas, Louisiana, Arkansas, and Mississippi. In

response to this threat, entomologists in these states recommended pyrethroid resistance management systems based primarily on the use of alternative insecticides, such as organophosphates and carbamates, in early and late-season. However, these systems were implemented with little knowledge of their effects on other serious pest populations.

In 1988-90, AAES researchers conducted experiments to determine if cotton aphid control failures in Alabama were due to the development of insecticide resistance. Experiments also were conducted to determine some reasons for aphid outbreaks and the impact of a pyrethroid resistance management system on aphids.

In 1988 and 1990, several populations from throughout Alabama were found to have developed resistance to many commonly used insecticides, including pyrethroids and organophosphorus compounds. Thus, control difficulties were, at least in part, due to insecticide resistance. Resistance developed rapidly in response to insecticide applications, but fortunately, it was also lost rapidly when insecticide pressure was reduced. In 1989, virtually no resistance was found.

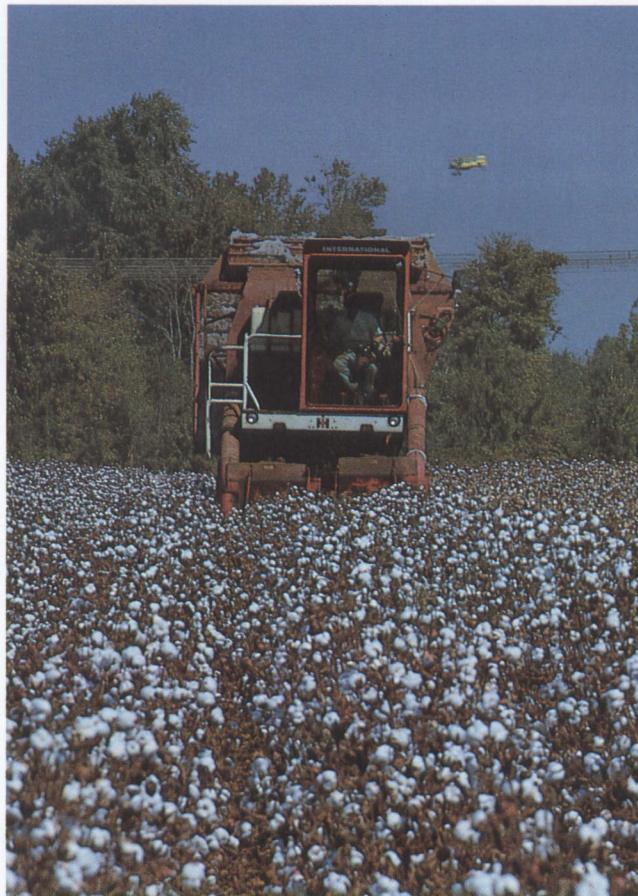
Cotton aphid outbreaks were induced by insecticide applications, which reduce beneficial insect populations. In 1 year of this study, key beneficials were small predators and pathogenic fungi. In another year, key natural control agents were parasitoids and small predators. Unfortunately, in both years the non-pyrethroid insecticide used in early season in the resistance management system caused a greater aphid outbreak than did the pyrethroid. This outbreak was not entirely due to destruction of beneficial insect populations, but

appeared to be partially due to insecticide-induced changes in the cotton plant.

## WEED HEIGHT REDUCTION REDUCES MOISTURE COMPETITION

Sicklepod is a problem weed which can reduce soybean yields as much as 30 percent at a density of one weed per foot of row. Control of the weed is possible through use of herbicides, although many herbicide treatments will only damage sicklepod and reduce the weed height rather than completely kill it. By understanding how the height of sicklepod affects its ability to compete with soybeans for soil moisture, producers will be able to make more economical weed control decisions.

In a recent test near Auburn, sicklepod was grown at densities of 3 per foot of row. Sicklepod was allowed to grow unrestricted in one treatment, clipped to the height of the soybeans in another treatment, and clipped to half the height of soybeans in a third treatment. These heights were maintained from 4 weeks after planting to harvest.



Increased aphid damage in cotton was directly linked to certain pesticide applications.

and 1.3 ounces per day for unrestricted, clipped to soybean height, and clipped to half of soybean

height, respectively. Clipping sicklepod to half the height of soybeans improved yields 35 percent.

Reduction in sicklepod height played a major role in the water use of soybeans by reducing the amount of water taken from the soil by sicklepod, thereby leaving more water for soybean use.

## NEW VACCINE EFFECTIVE FOR 1 TO 7-DAY-OLD CHICKS

Auburn research evaluated a new reovirus vaccine for vaccination of chickens between 1 and 7 days of age. This product, Enterovax®, is a modified live virus vaccine made from a mild-reacting, cell-cultured cloned reovirus.

In the first trial, day-old specific pathogen free (SPF) broilers were used. Reovirus vaccine was mixed with Newcastle disease (ND) and infectious bronchitis (IB) and given as a coarse spray (CS), and with infectious bursal disease (IBD) virus vaccine and given to chicks by subcutaneous injection (SQ) at 2 weeks of age. Chicks were then challenged with virulent reovirus at 2 weeks of age. Results showed that vaccinated chicks had resistance to infection as indicated by the absence of gross lesions and high body weights at 42 days of age. Antibody titers against IBD, ND, and IB showed no interference among the four vaccine viruses.

Trial 2 was done with commercial broilers having maternal antibody to reovirus. Birds were vaccinated at 1 day of age with reovirus. Some of the Enterovax vaccinated birds also were given Marek's Disease (MD) vaccine. At 2 weeks, birds were challenged with either virulent MD or reovirus. Results showed that vaccinated challenged birds had significant resistance to reovirus at 7 weeks of age. MD challenge results showed no interference with the two vaccines.

The third trial was done in commercial broilers with maternal immunity vaccinated under commercial conditions. Birds were vaccinated either in the company's hatchery at 1 day of age by CS or at 7 days of age in the broiler house. Some of the 7-day-old vaccines received reovirus vaccine by CS and others by drinking water (DW).

Birds were challenged with reovirus at 21 days of age. Birds vaccinated at 1 day by CS, or 1 and 7 days by CS, or at 7 days by CS, or 1 day by CS

and 7 days by DW had protection against challenge at 6 weeks of age. However, a single vaccination at 1 day of age was inferior to the other three vaccination regimes. There were no differences in results between the three 7-day vaccine regimes, indicating that a single vaccination at 7 days by CS or DW is sufficient to induce resistance to infection. Results indicated that Enterovax given by CS or DW route between 1 and 7 days of age will effectively induce immunity in broilers with maternal antibody and will not interfere with other vaccines given simultaneously.

## BETTER USE OF LIGHT CUTS POULTRY ENERGY USE

Growing chickens on short days and then exposing them to long light periods each day is well known for stimulating onset of egg production. From this basic principle has evolved the standard practice of rearing broiler breeder replacements on a daily light regime of 8 hours light and 16 hours dark when birds are from 2 to 20 weeks of age. It is not known, however, if shorter days could be used without reducing the benefits of the controlled light system. Reducing the hours of light would be desirable because this could reduce energy requirements for lighting and thereby lower cost of rearing replacements.

An AAES study was done to determine if different periods of daily light could be used without detrimental effects on broiler breeder replacements.

After 1 week in which all birds were subjected to 23 hours of light and 1 hour of darkness daily, these four light:dark ratios were compared:

- 4 hours light: 20 hours dark
- 6 hours light: 18 hours dark
- 8 hours light: 16 hours dark
- 10 hours light: 14 hours dark

Results show that females grown out with 4 hours of light:20 hours of dark daily matured 11 days later than those raised on 6, 8, or 10 hours of light. As a result, the 4-hour light females reached peak production later than the others, had lower production during weeks 23-30, and had lower total production to 50 weeks of age. In contrast, there was no difference in production to 50 weeks among those raised on 6, 8, or 10 hours of light daily. In males, sexual maturity was delayed for 7 days by the 4-hour daily light regime. There were

no differences among the 6, 8, and 10 hours daily light groups. Body weight, semen concentration, and semen volume were unaffected by lighting.

Since the results show no differences among the lighting regimes using 6, 8, and 10 hours of light per day, regimes other than the standard 8 light:16 dark can be used for rearing broiler breeder replacements. Where climate-controlled housing is used, the 6 light:18 dark regime offers an opportunity for reducing energy requirements for lower utility costs. For operations using natural light and natural ventilation, the 10 hours light:14 hours darkness regime would be more economical.

## AVOIDING LATE PEANUT PLANTING REDUCES LESSER CORNSTALK BORER

The effect of planting date and tillage system on the abundance of several insects in conventionally tilled *Florunner* peanuts was examined in a 2-year, replicated field experiment at the Wiregrass Substation in Headland. Late May and



Late planting date increases risk of lesser cornstalk borer damage in peanuts.

mid-June planting dates and conventional, reduced, and burned-stubble tillage systems were evaluated.

Burned stubble was evaluated because the literature indicates that lesser cornstalk borer moths may be attracted to recently burned areas. The abundance of the two pests (lesser cornstalk borers and click beetles) and two predators (ground beetles and earwigs) was monitored weekly with pitfall traps.

Lesser cornstalk borer, earwig, ground beetle, and click beetle counts varied with year. More lesser cornstalk borers and ground beetles were captured in traps in 1986 than in 1987, whereas more click beetles and earwigs were captured in 1987. Approximately 1.9-fold more lesser cornstalk borers were captured in traps from late-planted peanuts in both years. Earwig abundance was unaffected by planting date. Ground beetles were more abundant in late-planted peanuts in 1987, but planting date did not affect abundance in 1986.

Tillage system did not affect the abundance of any of the insects monitored in either year, and no increase in lesser cornstalk borer abundance in burned-stubble plots was noted.

These experiments indicate that avoiding planting late should effectively decrease lesser cornstalk borer abundance, and that burning stubble will probably not increase lesser cornstalk borer abundance.

## OUTLYING RESEARCH UNITS PROVIDE DIVERSITY FOR RESEARCHERS

The Alabama Agricultural Experiment Station is headquartered at Auburn University, but it has research units located throughout the State. Most of these are called "substations," with the name derived from a "sub" unit of the Main Agricultural Experiment Station at Auburn. This system of outlying research units provides researchers with the opportunity to conduct tests in different soil types and under different climatic conditions, bringing localized technological advances to all parts of the State. Many of the project summaries in this publication include data from one or more outlying units.

The roots of the outlying research system, which now consists of 11 substations, three experiment fields, four forestry units, the E.V. Smith Research Center, and two other locations, go back to the Alabama Legislature of 1927. This forward-thinking group of legislators passed an act providing for no less than 10 experiment fields and five substations to be located in the five primary soil districts of the State.

The five original substations, located at Belle Mina in the Tennessee Valley, Crossville on

Sand Mountain, Marion Junction in the Black Belt, Headland in the Wiregrass, and Fairhope on the Gulf Coast, are still an integral part of the outlying unit system. Between 1945 and 1948, additional substations were established at Camp Hill in the Piedmont, at Winfield in the Upper Coastal Plain, and at Camden in the Lower Coastal Plain. To support specialized agriculture, horticulture substations were established at Cullman (North Alabama Horticulture Substation) and at Clanton (Chilton Area Horticulture Substation). To serve the State's growing nursery industry, the Ornamental Horticulture Substation was established in Mobile.

The latest edition to the outlying research system, The E.V. Smith Research Center, is in reality an extension of the Main Station research facility. As enrollment continually increased at Auburn University in the late 1960's and early 1970's, it became evident that the old, soil-worn research areas on campus would have to be moved to allow for expansion. The culmination of this shift in research facilities came in 1978, with the dedication of the E.V. Smith Research Center in Shorter. Located about 30 miles south of Auburn, the 3,800-acre Center is divided into beef cattle, dairy-ing, agricultural engineering, horticultural crops, and agronomic crops areas.

Collectively, these outlying units provide one of the top research facilities in the Nation. Researchers can conduct tests on a wide range of soils and climatic conditions. For example, corn, cotton, and soybeans are grown statewide, but production problems in the Tennessee Valley may not exist on the Gulf Coast.

The outlying research units provide an opportunity to conduct tests on specialized crops that are endemic to particular areas of the State. For example, peanuts are grown only in a 12-county area in southeast Alabama, yet this crop is annually among the top money-making row crops in the State. Field tests on peanuts outside this area would not be applicable to problems encountered by growers, because of soil and climatic differences.

The outlying unit system also provides facilities for researchers to conduct research on specialized crops and commodities. For example, much of the fruit and vegetable research is conducted at the two horticulture substations, while specialized work to help the State's nursery industry is conducted at the Ornamental Horticulture Substation.

This diversity allows small teams of AAES researchers the opportunity to field test concepts and theories and greatly eliminate geographic differences as causal agents. The AAES outlying research system also provides the statewide and specialized field testing necessary to provide data used by the Cooperative Extension Service to base recommendations for various crop and livestock production practices.

Another value of outlying units is the opportunity offered to farmers, home owners, and other Alabamians to view research first hand. Field days and other open house programs held each year make Auburn research readily available to the public.

## **ALABAMA AGRICULTURAL EXPERIMENT STATION REPORT OF REVENUES FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 1990**

<b>Appropriated Funds</b>		
State	\$15,497,148	51.3%
State paid employee benefits	1,804,496	6.0%
Federal	3,964,429	13.2%
<b>Contracts and Grants</b>		
Federal	1,979,598	
State	843,005	
Private	<u>2,169,555</u>	
	4,992,158	16.5%
<b>Auxiliary Revenues</b>		
Sales of research projects	3,128,065	
Diagnostic services & feeds	253,832	
Interest and royalties	197,991	
Indirect & other cost recoveries	<u>356,178</u>	
	3,936,066	13.0%
<b>Total Revenues</b>		
	<u>\$30,194,297</u>	100.0%

## DIRECTOR'S RESEARCH AWARDS



Dr. Jacob Dane



Dr. David South

Dr. Jacob Dane, professor of agronomy and soils, was the recipient of the 1990 Senior Director's Research Award. Dr. David South was the recipient of the assistant and associate professor level Director's Research Award. Each award includes a \$10,000 grant to be used for research by the winning scientist.

Dane is an internationally recognized authority in the area of hydraulic properties of soil. These data are essential to development of computer models that can predict water movement through soils. He developed a new procedure that minimizes the differences between predicted and measured water content and was instrumental in improving the soil water flow equation through the introduction of an adaptive grid spacing technique.

South is an associate professor of forestry and is well known throughout the State, national, and international forest industries for his expertise in forest regeneration. He is probably best known for his work with forest herbicides, which are now used extensively and save forest nurseries in the South an estimated \$2 million annually.

### OTHER RESEARCH AWARDS

- Dr. Christine Sundermann was selected Alumni Professor for outstanding research and teaching in parasitology and protozoology
- Dr. Rodrigo Rodriguez-Kabana was elected Fellow in the Society of Nematologist and Honorary Member (highest award) of the Organization of Tropical American Nematologists.
- Dr. Lee Stribling was chosen Wildlife Conservationist of the Year by the Alabama Wildlife Federation.
- Dr. Keith Causey was selected Wildlife Educator of the Year by the Alabama Wildlife Federation.
- Dr. Kira Bowen was appointed as a 3-year Associate Editor of Phytopathology Journal.
- Dr. Paul Backman was named Associate Editor of Plant Disease Journal.
- Dr. Gareth Morgan-Jones was selected as Editor of Cryptogamic Botany.
- Dr. Barry Jacobsen is President-Elect of the Association of Plant Pathology Department Heads and Chairpersons.
- Dr. James Sartin was elected Editor of Domestic Animal Endocrinology.
- Dr. C.R. Rossi was named President of the American Association of Veterinary Immunologists
- Dr. Victor Panangala was elected to the Board of Scientific Reviewers of the American Journal of Veterinary Research.
- Dr. David Stringfellow is Editor of the Second Edition of the Manual of the International Embryo Transfer Society.
- Dr. Troy Best was named Editor-in-Chief of the Journal of Mammology.
- Dr. Nick Hollar was named Editor-in-Chief of the Wildlife Society Bulletin.
- Dr. Ralph Mirarchi was named Editor-in-Chief of the Journal of Wildlife Management.
- Dr. Bill Fisher received a Special Achievement Award from the U.S. Fish and Wildlife Service.
- Dr. Tom Lovell was appointed to the Committee on Animal Nutrition by the National Research Council of the National Academy of Sciences.
- Dr. John Plumb received the S. F. Snieszko Distinguished Service Award from the Fish Health Section of the American Fisheries Society.
- Dr. Cliff Flood was awarded the Distinguished Agricultural Engineer Award by the Alabama Section of the American Society of Agricultural Engineers.
- Dr. Bill Hardy was elected President of the Southeast Decision Sciences Institute.
- Dr. John Adrian was elected President of the Southern Agricultural Economics Association for 1990.



