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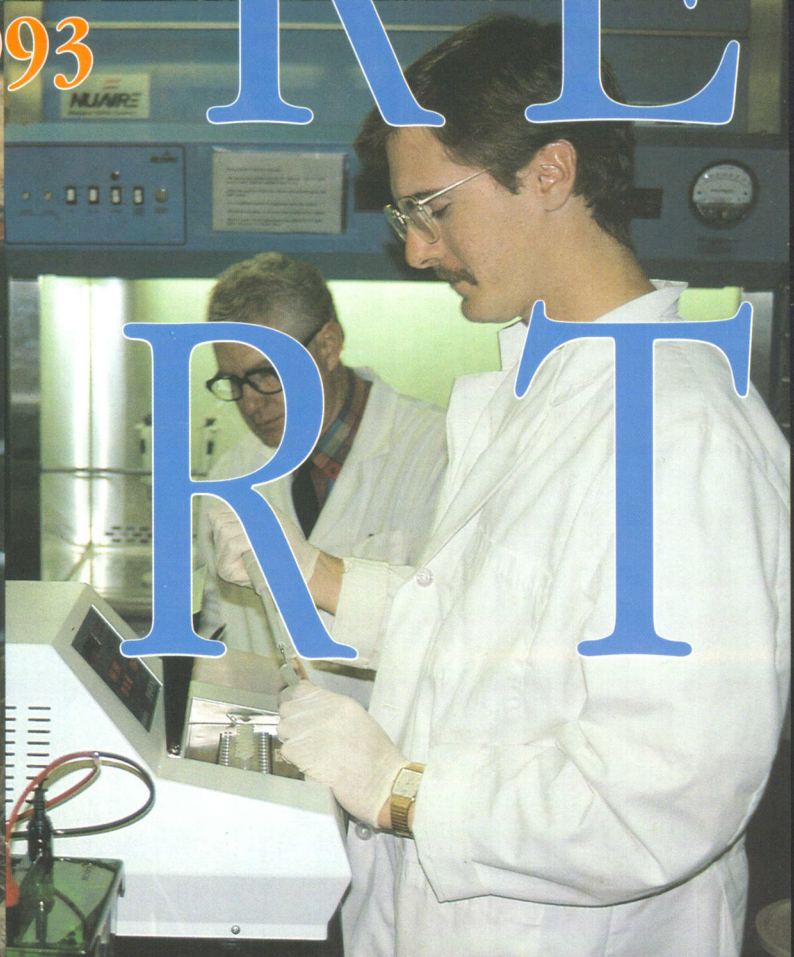
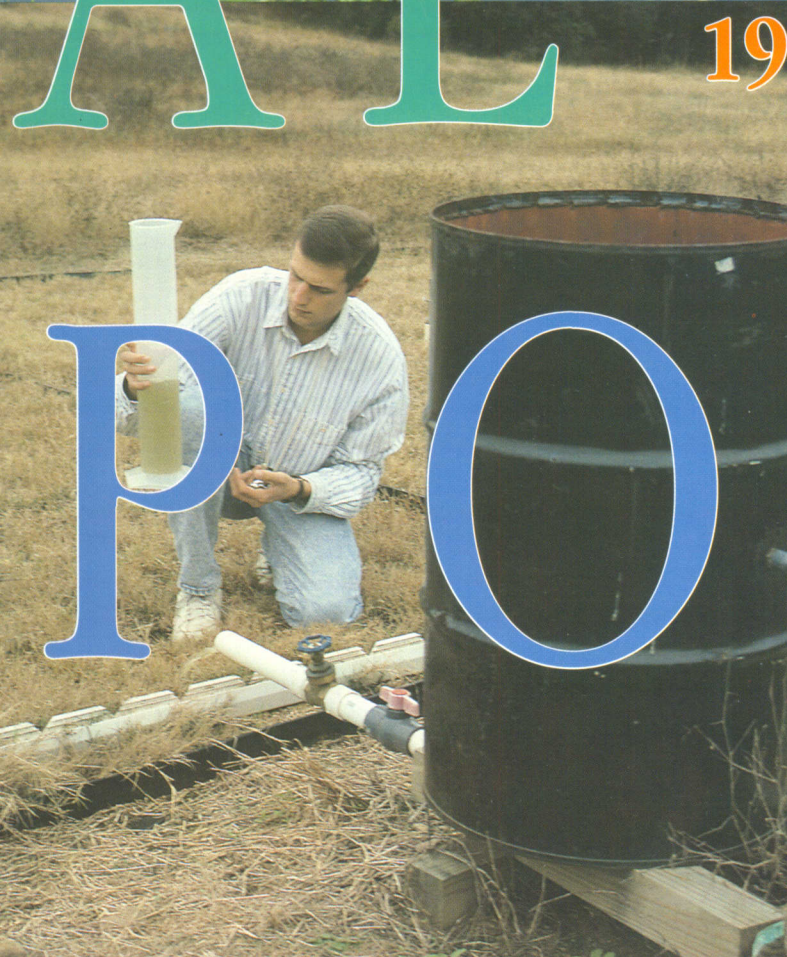
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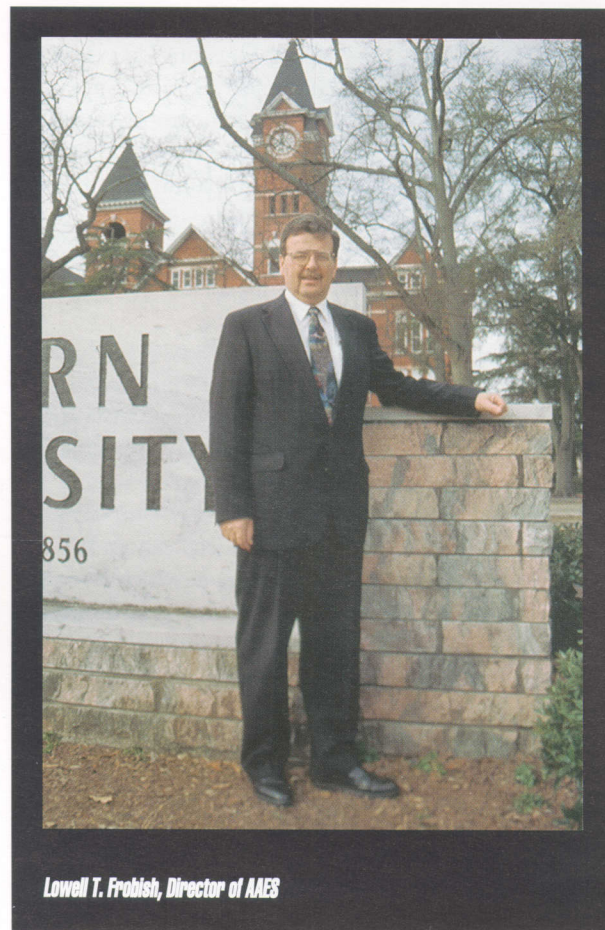
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FOREWORD



Lowell T. Frobish, Director of AAES

Research conducted by the Auburn University faculty and staff who constitute the Alabama Agricultural Experiment Station is ever-changing, but the traditional land-grant mission of providing innovations vital to the production of food and fiber, the protection of our natural resources, and improving the quality of life for all Alabamians has remained constant after more than a century.

Whether our efforts

were directed toward developing or perfecting new technology, such as a genetically engineered cotton variety or a procedure for producing test-tube calves ... addressing age-old problems, such as crop pests or livestock disease ... or confronting social issues, such as children's health care or changes in rural life ... AAES scientists in 1993 continued to excel in meeting the needs of Alabama producers and citizens.

AAES research provided direct benefits to many of the industries that are the backbone of Alabama's economy — forestry, livestock, aquaculture, recreation, and fruit, vegetable, and row crop production. The Experiment Station is not only dedicated to improving the state of the art in these areas, it is dedicated to providing economical technology and techniques that can be implemented without harming or depleting the state's

valuable natural resources. Environmental protection is a primary goal in many AAES projects, as is the enhancement of Alabama's most important resource — its citizens.

One of 1993's biggest developments with implications for the Experiment Station was the establishment of the AU Food Technology Institute (FTI). AAES scientists have conducted nutrition, food safety, and food product research for decades. The institute is still in an early stage of development, but when it gets up and running, it promises to make these already active research programs even more productive. The FTI Administrative Board hopes to appoint a director for the institute in early 1994.

It would require an annual report roughly the size of the Birmingham telephone directory to cover every AAES research project underway in 1993. However, the following pages summarize a cross section of the year's developments and hopefully convey the breadth and scope of the entire Experiment Station research program.

Lowell T. Frobish
AAES Director

Producers Benefit from 1993 AAES Research

Throughout its 110-year history, the Alabama Agricultural Experiment Station has improved the production of timber, livestock, crops, and other commodities in Alabama. AAES researchers in 1993 continued Auburn University's tradition of excellence in providing innovations for the direct benefit of producers and the ultimate benefit of consumers. Researchers emphasized not only the economic reality of implementing new technology, but also its impact on the environment.

Confronting crop and livestock disease and pest problems, developing new crops and improved animals, and testing innovative new technology and production techniques

were some of the areas in which researchers excelled. The following pages present a brief overview of projects exemplary of the wide-ranging Experiment Station research program last year.

TRANSGENIC COTTON A GOOD BET FOR ALABAMA FARMERS

AAES agronomists have shown that a new genetically engineered cotton variety is unaffected by herbicide applications that kill normal cotton and several common weeds. BXN, a "transgenic" cotton variety developed by Calgene Inc. of California, contains a bacterial gene that makes it resistant to the herbicide bromoxynil.

No visual injury was seen in BXN cotton treated with up to 1.5 pounds per acre of bromoxynil. Treatments one-third as strong killed non-transgenic cotton.

Bromoxynil provided excellent control of velvetleaf, entireleaf morningglory, prickly sida, tropic croton, and other weeds. BXN seed should be commercially available by 1995.

TEST-TUBE CALF RESEARCH CONTINUES

AAES pathobiologists and AU veterinarians successfully used in-vitro fertilization (IVF) to produce embryos from a valuable registered cow with terminal, viral-induced cancer. IVF is a procedure in which an egg from one cow is fertilized in a laboratory setting and transferred into a surrogate mother. Three embryos from the cow were transferred, but at press time the pregnancy status of recipient cows had not been determined.

Researchers also are investigating a concern that IVF mainly produces bull calves. One theory is that faster-growing eggs develop into male embryos, and the most advanced eggs are the ones usually collected for

transfer. By preferring slower-growing eggs, researchers got a higher percentage of heifers. More research is needed to determine if this method consistently results in a normal sex ratio.

In other studies, researchers experimented with an IVF method called "trans-vaginal ultrasound-guided aspiration," which uses an ultrasound-guided needle attached to a suction pump to remove eggs. It is expected that this procedure can be performed up to twice a week without interfering with long-term fertility, whereas traditional IVF procedures required surgery to retrieve eggs.

AAES RESPONDS TO TOMATO VIRUS

Viral epidemics in 1992 and 1993 severely reduced tomato production in Alabama. In response to the virus problem, AAES researchers launched a program to reduce the effects of future outbreaks.

They found that the

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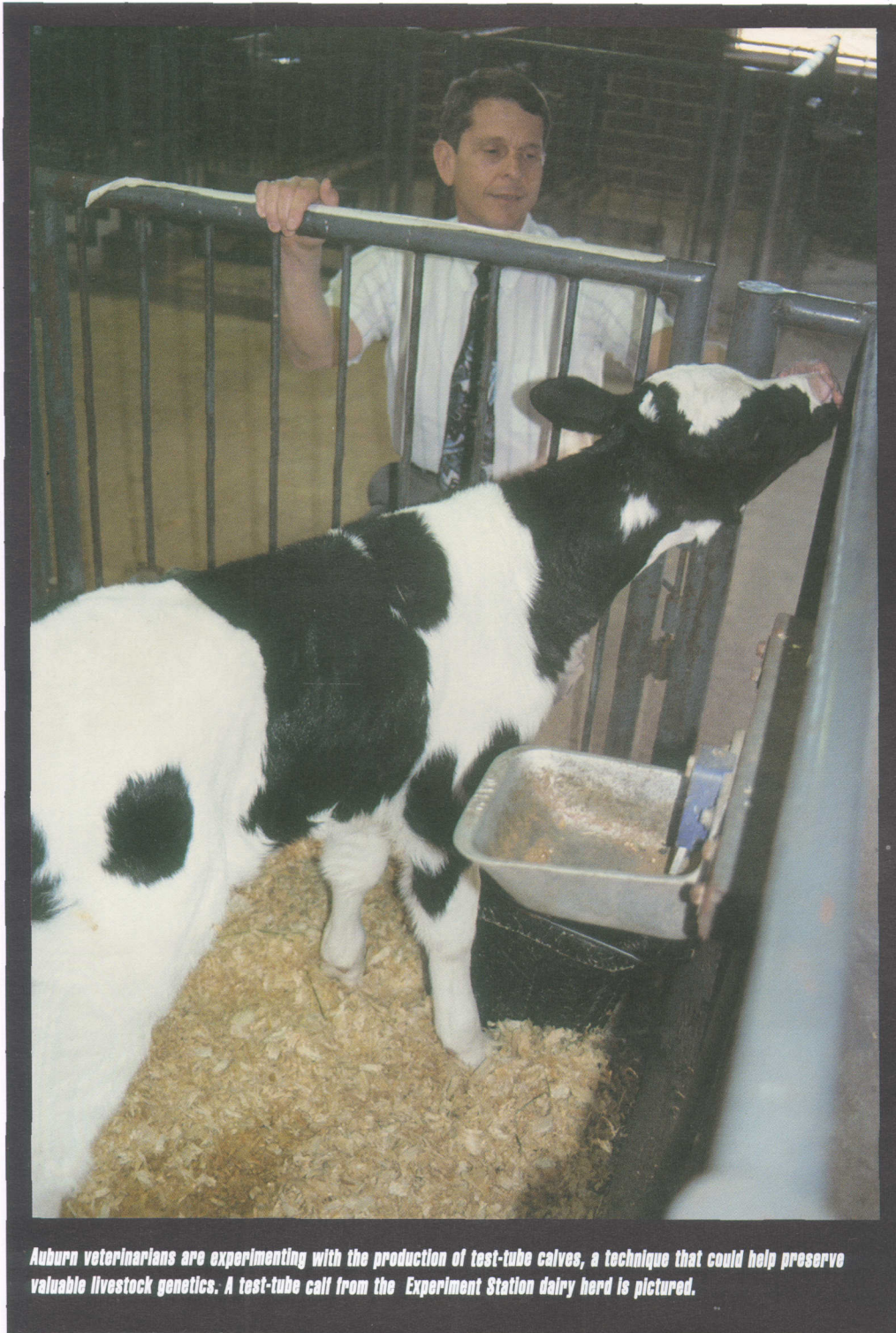
LYME DISEASE IN ALABAMA

Although approximately 80% of dogs in the Northeast are exposed to Lyme disease, AAES entomologists and AU veterinary researchers found almost no evidence that the tick-borne

disease affects dogs in Alabama. A state-wide survey and a two-year field study in Lee County, where human cases have been documented, revealed few signs of canine Lyme disease and no con-

firmed clinical cases. Practicing veterinarians from across the state provided blood serum samples from dogs not vaccinated for Lyme disease; only 1.7% of the 579 samples showed signs of exposure to

the disease. Results indicate that dogs are at low risk and Lyme disease vaccination is not justifiable in Alabama, even where human cases are documented.



Auburn veterinarians are experimenting with the production of test-tube calves, a technique that could help preserve valuable livestock genetics. A test-tube calf from the Experiment Station dairy herd is pictured.

disease problems were caused by the cucumber mosaic virus, potato virus Y, and/or the tobacco etch virus, which are spread by aphids. The green peach aphid and potato aphid were identified in the affected fields. Studies indicated that

possible overwintering hosts of the viruses include collards, turnip, mustard, broadleaf dock, white clover, honeysuckle, wild garlic, henbit, and wild geranium.

Virus incidence usually remained low until three weeks after transplanting in

the earliest settings, and symptoms were mild. However, in fields transplanted after June 1, incidence increased more rapidly, and in most cases the crop was not harvestable.

OVERLAND DISPOSAL OF LAGOON EFFLUENT

Many swine, dairy, and egg producers use liquid waste management systems in their production areas. The effluent storage and treatment process usually involves some type of lagoon.

AAES agricultural engineers and agronomists are adapting a technique used in municipal waste treatment to dispose of lagoon effluent by overland flow for forage production. Effluent is pumped to the uphill side of a sloped field. It then is released through perforated pipes to flow down the field.

Researchers are loading swine effluent on fields at various rates of nitrogen to determine its effects on the growth of Bermuda grass. Goals are to learn how to most efficiently apply effluent and to monitor runoff and leaching water quality.

PREDICTING LESSER CORNSTALK BORERS

1993 was a good test year for an AAES-developed system for predicting outbreaks of lesser cornstalk borers (LCB), a major pest in peanuts. A simple prediction equation helped entomologists more accurately time scouting and pesticide application for the insects.

The system predicts when conditions are best for the insect by recording daily temperatures and rainfall after peanuts are planted. A 95^o-day with no rain is +1 "LCB day" on the scale; less

than 95° with at least one-tenth inch of rain, -1 LCB day. Researchers found that 0-10 LCB days meant scouting was needed. Danger existed at 5-10 LCB days, and damage occurred at more than 10. When LCB days were mostly negative, the insects were rarely found. Insecticide applied after negative LCB days did not increase yields.

With accurately timed scouting and pesticide use, fewer plants are sacrificed in the search for insects and insecticide applications are more effective. If insecticides are applied too early, they can degrade in as few as 19 days in the hot, dry weather that favors the lesser cornstalk borer. If treatments are applied too late, much of the damage already will have occurred.

ASSESSING ROOT DISEASES OF WHEAT

AAES plant pathologists conducted the first complete study of wheat root and crown rot diseases in Alabama, providing in-depth information on the distribution and prevalence of soilborne fungal pathogens.

Researchers found extensive infestations of take-all root rot in North Alabama and to a lesser degree in Mobile and Baldwin counties. Common root rot and Fusarium foot rot were found throughout the state. Rhizoctonia root rot was found mostly in South Alabama.

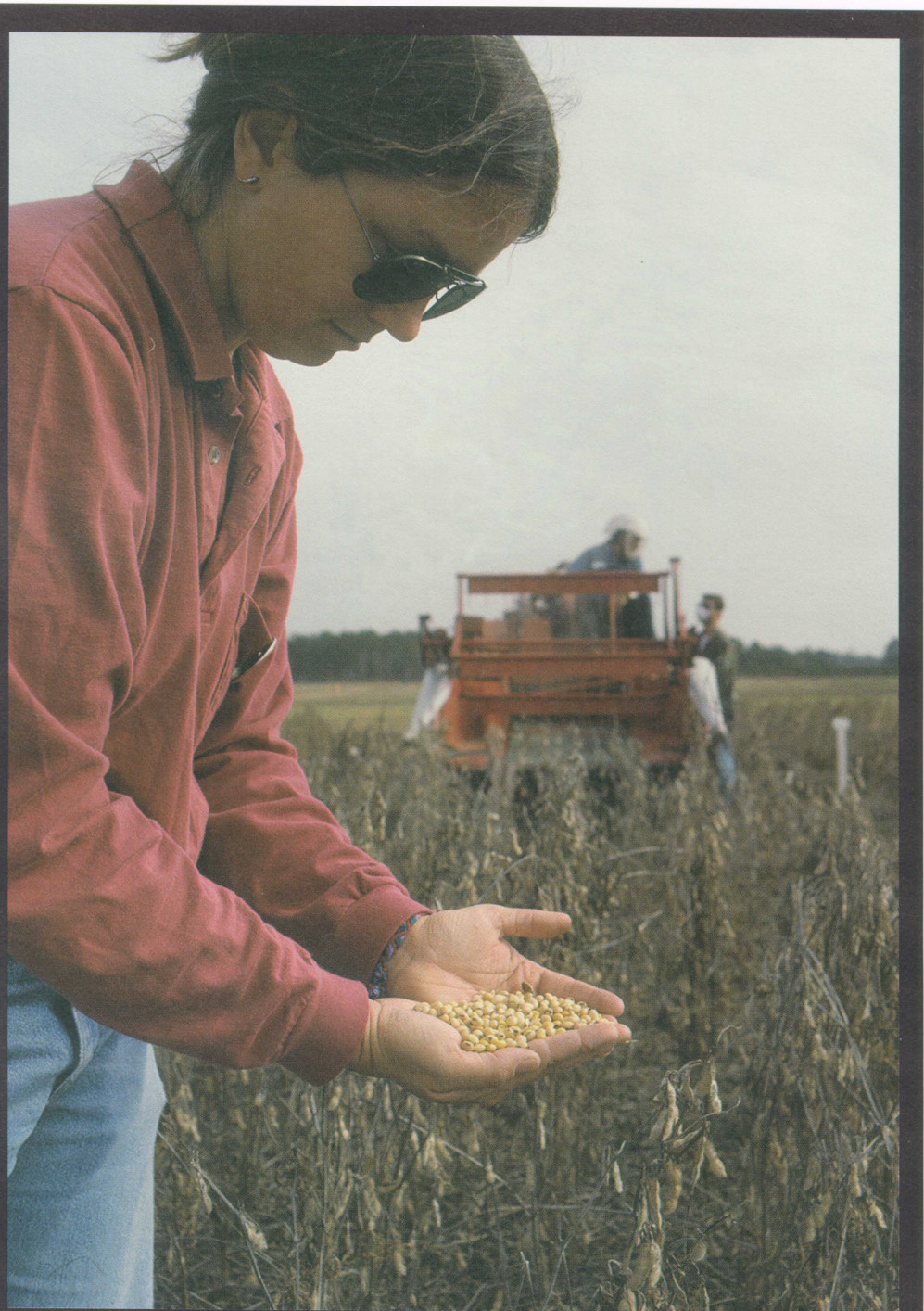
The survey will serve as a basis of future efforts to

control these pathogens. Researchers also examined healthy root systems to isolate beneficial bacteria for use as biological control weapons against the pathogens and other pests.

NEW SOYBEAN VARIETY DEVELOPED

AAES agronomists hope to release a new soybean cultivar in 1995. The cultivar matures early, produces good yields, and is resistant to several major soybean diseases.

AU87-547 combines resistance to both major root knot nematode species, two of the most common types of soybean cyst nematodes, and frogeye leaf spot. Seed yield of AU87-547 on a site with severe nematode infestation was 25.7 bushels per acre,



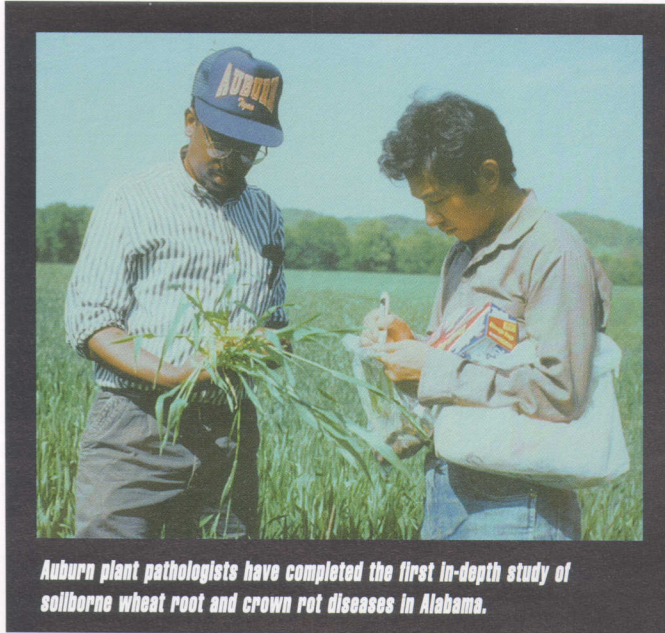
A new soybean variety developed by AAES researchers matures early, is resistant to several major diseases, and produces yields equal to or greater than other popular varieties. The new cultivar should be available in 1995.

compared to other nematode-resistant cultivars, Bryan, 22.1 bushels; and Leflore, 17.4 bushels. AU87-547 matured 2-4 days earlier than other resistant varieties.

DEVELOPING LEAN, BUT HEALTHY HOGS

The effort to develop leaner swine has concentrated the genes for porcine stress syndrome, which can kill hogs or cause them to produce poor-quality meat. AAES animal scientists are using a DNA test to detect syndrome-related genes in an effort to breed lean hogs without passing along the disorder.

Hogs with stress syndrome are leaner and convert feed more efficiently. Researchers want to determine exactly which genes are related to the positive traits and whether they can be separated from the genes that control porcine stress syndrome. Such information could be used to breed lean, efficient animals that are not prone to porcine stress syndrome.



Auburn plant pathologists have completed the first in-depth study of soilborne wheat root and crown rot diseases in Alabama.

EFFECTS OF FEEDING BROILER LITTER TO BEEF COWS

A large amount of broiler litter is fed to cows in the months before they calve, and these animals sometimes show signs of milk fever 1-3 weeks after calving. Animals can be treated for the debilitating disease, but calves cannot nurse while the cows are down.

To investigate this problem, AAES animal scientists fed some cows a diet of 80% litter/20% corn, while others were fed a control diet of hay. Some cattle also were given a feed

additive of ammonium-chloride. Out of 45 cows, only one had clinical signs of milk fever, and it was on the control diet. However, the cows on litter without the additive did have lower calcium levels.

DEVELOPING NEW FORAGE CROPS

AAES agronomists released Alabama's first new crimson clover variety in decades. AU Robin is an early-maturing winter cover crop that provides high-protein feed for livestock.

The forage reaches full bloom 7-10 days earlier than

Tibbee, the earliest maturing crimson clover previously available. This benefit allows AU Robin to be left in the ground long enough for producers to take advantage of its full nitrogen-fixing ability and still get a jump on preparing fields for summer crops. AU Robin yielded an average of 3,513 pounds of dry matter per acre, compared to 3,447 pounds for Tibbee.

In other forage research, agronomists are conducting a regional study of sweet white lupins, an annual legume with great potential for use as a winter cover crop and high-protein feed grain. Efforts funded in part by the Alabama Farmers Federation are directed toward developing a new lupin variety that flourishes in Alabama's climate.

NEW INFORMATION ON CATFISH NUTRITION

AAES fisheries experts in 1993 made several important findings for catfish producers. In one study,

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PLANT EFFECTS ON BASS

Most bass anglers prefer to fish near aquatic plants because of the beneficial effects vegetation has on bass populations, but excessive plant growth can prevent other recreational activities in

public reservoirs, such as skiing or sailing. Experiment Station fisheries scientists found that bass reproduction in Lake Guntersville was not necessarily related to the amount of aquatic vegetation, but rather

to the amount of water coming into the reservoir during the spring when the fish were spawning. During high periods of rainfall between April and June, the reservoir flushes much faster, diminishing the

food supply of young bass and making it harder for them to survive. However, aquatic plants do help to dampen the negative effects of high inflow coming into the reservoir.



Alabama's growing catfish industry will benefit from AAES fish nutrition research. In one study, aquaculture experts showed that catfish can go without food for three weeks in the growing season and still reach normal weight by harvest.

researchers compared the effects of feeding catfish supplements of fish oil, animal fat, and vegetable oil. A combination of fish oil and vegetable oil promoted good growth and disease resistance. Catfish grew well on

fish oil but were more susceptible to bacterial infection.

Researchers also found that channel catfish are capable of compensatory weight gain. In other words, if they are placed on an

extremely restricted diet, then fed all they want, they will catch up with fish fed consistently. Fish taken off feed for three weeks caught up with control fish within three weeks. Those not fed for six weeks were 90% as large

as control fish at harvest; those not fed for nine weeks, 86% as large.

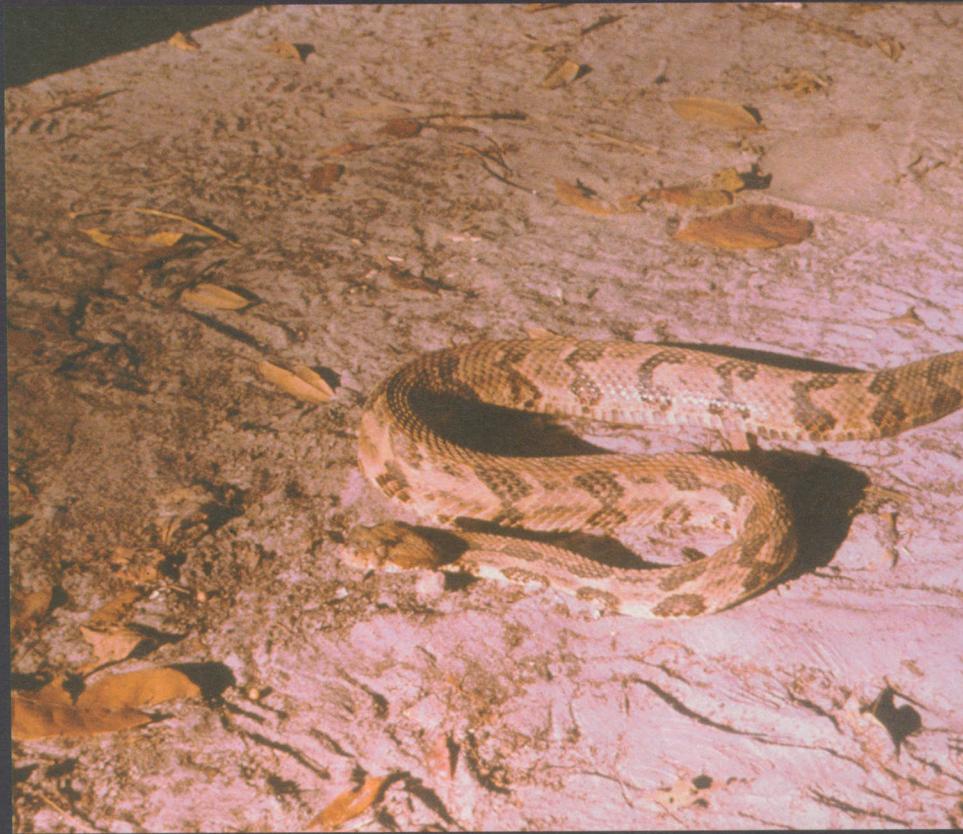
Winter feeding was previously thought necessary to maintain fish health and weight, but AU researchers proved otherwise. Catfish not fed December-February were the same size in April as those fed all winter. Those not fed from Nov. 1 to April 23 were 12% smaller at the end of winter, but due to compensatory weight gain, they attained normal weights by harvest.

INVESTIGATING A FATAL PARASITE

AAES zoologists are investigating a coccidian parasite called *Caryospora*, a microorganism proved fatal in some animals. The parasite can kill dogs, and it infects but is not fatal to swine. It can be transmitted by eating under-cooked meat from an infected animal. The effect of *Caryospora* on humans is unknown, but it has affected every mammal tested so far.

Caryospora causes coccidiosis that affects bone marrow, connective tissue, and other tissues. In dogs, it causes the face, eyes, muzzle, and foot pads to swell and develop infected lesions; the animals usually die 8-9 days after infection. Rattlesnakes, the primary hosts of *Caryospora*, spread the parasite's eggs in their feces.

Zoologists discovered that *Caryospora* is the only coccidian that can undergo



Zoologists are studying a sometimes fatal parasite called *Caryospora* (Inset), which can kill dogs and infect swine. The parasite is spread in the feces of rattlesnakes and can also be transmitted in under-cooked meat. Its effects on humans are not yet known, but it has infected every mammal tested so far.

complete, continuous development through its life cycle in a cell culture system. The ability to continuously study the parasite "in-vitro" allows researchers to view its growth and development and to test drugs against *Caryospora* and related parasites that cause coccidiosis in poultry and cattle.

CONSERVATION TILLAGE SAVES SOIL WATER

AAES agricultural engineers demonstrated that conservation tillage, which relies on plant residue left on the soil surface, provides cotton yields equal to conventional tillage while preserving much more soil water.

Cotton was grown for

five years using conventional tillage, reduced tillage, and reduced tillage with a winter wheat cover crop. Soil water content was the lowest for conventional throughout the growing season. At about eight inches, soil water content was the highest for reduced tillage with cover crop, but reduced tillage without a cover crop pro-

vided the greatest water content at depths below 15.7 inches.

Conservation tillage prevents soil erosion, slows runoff, reduces evaporation, and increases water infiltration. It also saves time, fuel, and labor.

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ADVANTAGE FOR CATFISH PRODUCERS

Alabama could gain a competitive advantage over the top catfish-producing states, Mississippi and Arkansas, under expected changes in effluent regulations, such as discharge restrictions or

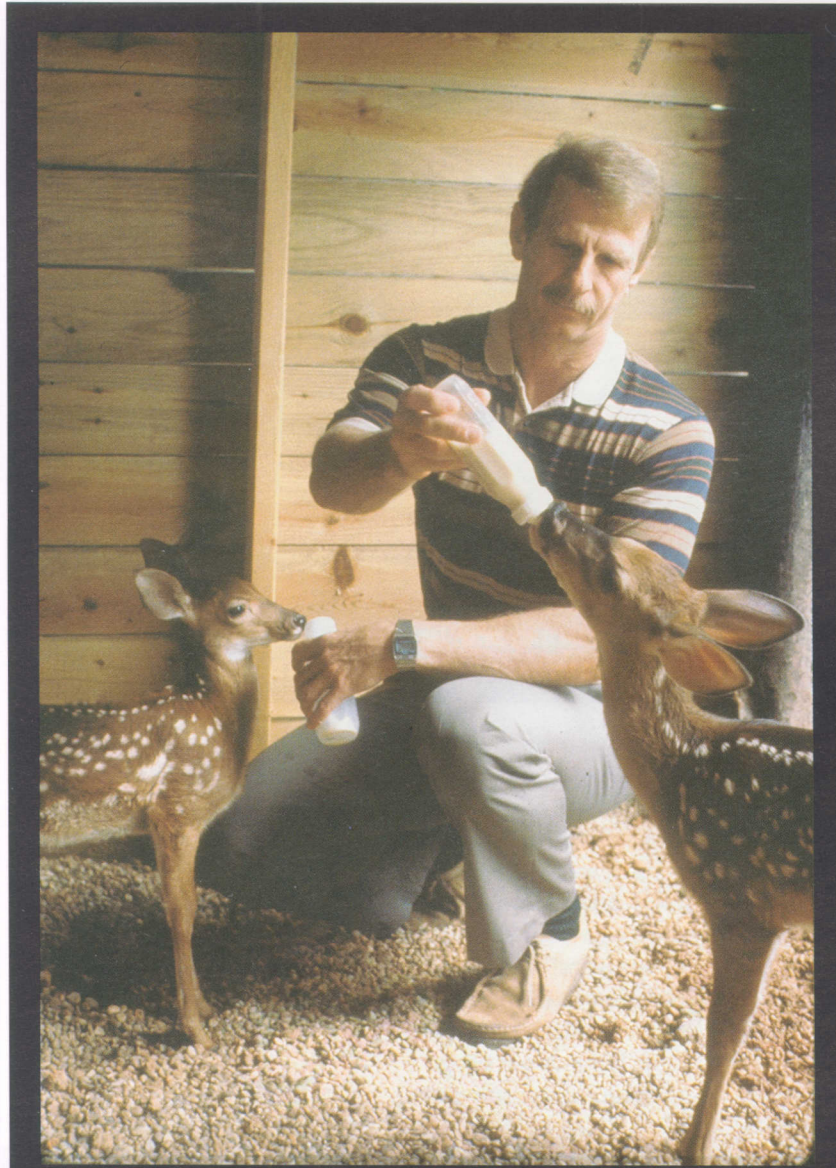
taxes, according to a study by AAES agricultural economists. Results suggested that watershed pond production would be preferred over levee production in methods to control the release of pollutants

into nearby streams. The flat terrain in Mississippi and Arkansas favors levee construction, whereas Alabama's terrain favors the less expensive watershed pond. The study also indicated that water recy-

cling is the least-cost treatment. However, producers would not decide to recycle water unless a tax of at least \$10 per unit of pollution is imposed.

AAES Deer Studies Support \$400 Million Alabama Industry

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Wildlife scientists captured and bottle-fed 55 fawns for studies at the North Auburn Deer Research Facility. These deer and their offspring are used in research designed to improve management practices crucial in maintaining Alabama's \$400 million deer hunting industry.

Deer hunting in Alabama generates more than \$400 million each year in sales of vehicles, clothing, grain, fertilizer, hunting permits, sporting goods, and other related goods and

services. Improved deer management helps the state's total hunting industry, which is valued at nearly \$700 million.

At the North Auburn Deer Research Facility and in

wilderness areas throughout Alabama, AAES wildlife scientists are involved in a wide-ranging research program dedicated to the type of real-world studies vital in maintaining and improving the state's white-tailed deer population.

In one recent study, researchers addressed the belief held by many hunters that Alabama deer are genetically inferior and new stock must be imported from other regions to improve the local population. Wildlife scientists showed that the growth potential of native white-tails is a factor of food quality,

not genetics. Protein was found to be an important limiting factor in deer growth and antler development. Deer need about 17% crude protein, but Alabama's wild vegetation provides only 8-

11%.

In 1987-88, 55 fawns were captured from around the state and taken to the Deer Research Facility, where they were bottle fed and weaned onto a special ration designed for optimum growth and antler development. At 18 months, the bucks all had branched antlers and weighed an average of 128 pounds, higher than the average weight of wild deer in the state.

These deer were bred and produced 60 fawns. Eighteen-month-old males of the first generation in captivity weighed an average of 142 pounds and developed four- to eight-point antlers. At two years, their weight averaged 198 pounds. One reached a phenomenal 240 pounds and developed a 22-inch, eight-point rack.

These findings illustrate that if fed properly, native deer can grow as well any deer. Deer adapt to their environment; if large deer were imported, their bodies would adjust in size to survive in the Alabama habitat.

Using the captive population, researchers also are addressing the issue of deer habitat improvement. With experimental plantings at the research facility, scientists are evaluating which combinations of forages deer managers can economically plant to furnish a year-round source of high-protein food. Deer are given



Alabama deer have the potential for great size and antler development if proper nutrition is available. This buck is typical of the deer produced in a study in which the animals were fed an optimum amount of protein.

access to various forage plots to determine which plants are most preferred.

One surprising finding was that ryegrass, a type of turf grass, is the most economical forage that deer favor. It is cheap to plant, produces more over a longer period of time, and voluntarily regrows the next year. Researchers found that planting a combination of ryegrass and crimson clover can give deer a boost in attaining their full growth potential.

Also in 1993, wildlife researchers completed a study of how transplanted deer respond to restocking programs. Results showed that the Alabama Game and Fish Division was successful in relocating deer from the Fred T. Stimpson Wildlife Sanctuary in Clarke County to the William B. Bankhead National Forest in Northwest Alabama.

Wildlife scientists placed radio transmitters on 30 of the stocked deer, which were then located daily using

aerial telemetry. Only three of the 30 died within a year after relocation, most likely due to post-release trauma. No deer were lost to poachers. Also, the deer did not move off the target release site during the study.

In other research, wildlife scientists are —

— developing guidelines for using electric fences and other techniques for excluding deer from fields and home gardens;

— determining the extent to which large body size and antler growth are inherited from bucks to their offspring;

— analyzing the effects of early weaning on the growth and development of fawns;

— testing the effect of providing supplemental minerals on deer's body size and antler development;

— developing a method for aging deer by measuring tooth growth, wear, and replacement, which should be much more precise than existing techniques.

AAES CAPSULE

CHAPTER 12 GOOD FOR FARMERS

A study by AAES agricultural economists indicated that the special farm provisions in the U.S. Bankruptcy Code have been beneficial to farmers. A significant number of Alabama farmers who have

filed for reorganization of their financial obligations under the guidelines provided by Chapter 12 have been successful in maintaining their farming operations. In addition, results of a survey

of Alabama attorneys who have worked with Chapter 12 cases indicated that over half felt that farmers had benefitted from the availability of Chapter 12 and that the special provisions of the law

should be continued. Results of the total study should provide valuable information to Congress as the provisions of the law are debated.

AAES Researchers Vital in AU'S New Food Technology Institute

Auburn University established the Food Technology Institute in 1993, a development that will enhance already active AAES research programs in the areas of nutrition, food safety, and development of new and value-added products.

Continued economic vitality in Alabama depends largely on research to improve the complex process of bringing food to consumers. Production of poultry, meat, fish, fruit, vegetables, and row crops represents a significant portion of Alabama's economy. In addition, about 300 food processing companies employ 30,000 people and return more than \$4.8 billion additional dollars through agribusiness to the economy.

AU's Food Technology Institute relies on active faculty in the colleges of Agriculture, Veterinary Medicine, and Sciences and Mathematics, and the School of Human Sciences to promote the interaction and interdisciplinary cooperation that is

needed to ensure continued growth in Alabama's agriculture- and food-related industries.

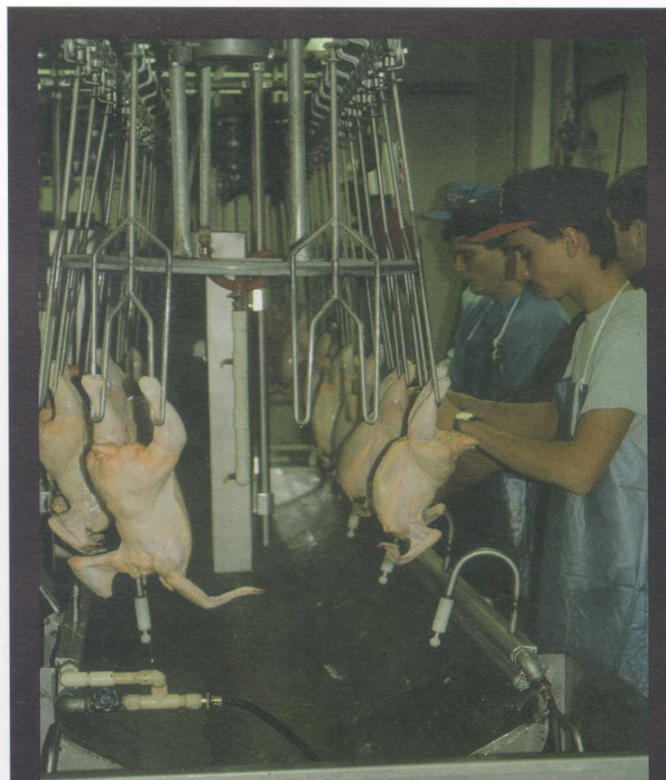
This article presents a cross section of AAES research designed to improve the food supply or solve problems facing food industries. With the advent of the Food Technology Institute, these and many other related projects are expected to become even more active and productive.

VALUE-ADDED MEAT PRODUCTS

One of Auburn's most prominent food science efforts was the development of the AU Lean low-fat meat products. The AU Lean research team has now developed an all-meat frankfurter with only 8% fat — compared to 30% fat in traditional franks. Consumer panelists report that the new frank looks like other franks and tastes as good as many all-beef products.

The formulation uses a product from a new commercial process for separating fat from lean meat. In the process, meat trimmings are finely ground, heated to approximately 100°F, and placed in a centrifuge until most of the fat spins out. The remaining lean meat is frozen and cut into small chips.

Other new products are under development using



Alabama's poultry industry stands to benefit from Experiment Station research aimed at developing value-added food products.

meat from cull cows treated with the growth hormone bovine somatotropin (bST). Cull cows are old, fat animals now slaughtered for ground beef. AAES research showed that bST injections reduce fat and increase muscle development in cull cows, producing leaner meat for higher value products.

Researchers are evaluating a breaded beef finger made from the tenderloin of bST-treated cull cows. Shelf-life and taste tests are underway for the product. Another product on the drawing board is a marinated steak from the rejuvenated cull cows.

Consumers of poultry products also stand to benefit from AAES research. Poultry scientists are working to stabilize poultry products to commercial preparation by altering the nature of fatty acids in chicken fat. Researchers plan to alter chickens' diets to contain monounsaturated fats that are stable enough to withstand the severity of further processing, freezing, microwaving, and deep frying and to maintain good taste and color. Goals also include making poultry products more healthful and extending their shelf life. Research also continues in

efforts to increase the amount of fillets and strengthen the skeletal structure of chickens.

PROTECTING CAVIAR-PRODUCING FISH

Harvest of the North American paddlefish increased drastically in the early 1980s because of the skyrocketing value of their eggs, which can be used as caviar. Overharvesting prompted the Alabama Department of Conservation to place a moratorium on harvest and possession of the fish in 1989.

AAES fisheries experts are assessing the current status of paddlefish in the Tallapoosa and Cahaba rivers. Researchers collected and tagged 906 fish during 1992-93 and analyzed factors affecting their distribution and abundance. Most fish were collected in the Tallapoosa River, and no fish moved between rivers. Spawning activity was documented in both rivers. Field work in the study is complete, and researchers are



AU Sweet Scarlet and other Auburn-developed watermelon varieties are internationally appreciated. Sweet Scarlet is valued not only for its flavor, but its yield and disease resistance as well.

working to quantify paddlefish age structure, mortality rates, and genetic composition. Results will help the Department of Conservation to continue reevaluating the moratorium.

DEVELOPING NEW CROPS

In addition to performing annual variety tests of the fruits and vegetables commonly grown in Alabama, AAES horticulturists work to develop new,

improved crops.

One new breeding line has the potential of putting Alabama into the shipping cantaloupe business. Breeding line "AC8237" is a multiple-disease-resistant melon with sweet, high-quality fruit. Its tough, thin rind approximately triples the cantaloupe's shelf life. The new line may be released in 1996.

Auburn is internationally recognized for its

watermelon research. Further strides were made in this program during 1993 as researchers produced the first hybrid melons with pollination by bees. This innovation, which eliminates expensive hand pollination, should greatly reduce the cost of hybrid seed.

Earlier watermelon varieties — AU Golden Producer and AU Sweet Scarlet — continued to gain recognition when the U.S.

AAES CAPSULE

MARKETING APPAREL IN MEXICO

Even before the North American Free Trade Agreement, Mexico was Alabama's fastest-growing apparel customer. Apparel exports to Mexico in 1992 were \$23 million, and market opportuni-

ties are expected to grow. Given the trend of increasing exports, state apparel manufacturers need to be aware of the preferences of Mexican consumers. AAES consumer affairs researchers studied

apparel buyer behavior and attitudes toward U.S. products in Mexico. Consumers there have very favorable opinions on U.S. apparel, but they have different tastes and needs than U.S. consumers. What

sells in the U.S. may not sell in Mexico, and what sells in Mexico City may not sell in Guadalajara. Further research will be conducted to refine the Mexican consumer profile.



Horticulturists hope to develop pear varieties that thrive in Alabama by relying on Mother Nature's "variety testing." Researchers have collected samples from 100-year-old European-type trees and grafted them onto new rootstock.

Secretary of Agriculture issued Plant Variety Protection Certificates for the melons. These varieties are

resistant to several of the South's most serious watermelon disease problems and are superior in yield and

quality.

In other fruit-related research, horticulturists hope to rely on Mother Nature's

"variety testing" to provide a high-quality pear tree for Alabama. Top-quality commercial cultivars such as Bartlett cannot be grown in the state because of susceptibility to fire blight disease. The cultivars that can be grown produce poor-quality fruit. Researchers have collected European-type pear trees that developed from the seedling rootstocks of trees planted on old Southern home sites 100 or more years ago. These trees not only survive fire blight, they continue to produce high-quality pears. The samples have been grafted onto new rootstock and propagated for experimental plantings this year.

Auburn horticulturists are equally active in vegetable research. Two AU-developed blackeye pea varieties should be approved for foundation seed production in 1994 and available for planting in 1995. AUBe, which stands for AU Blackeye, has an upright



This new blackeye is expected to be available in 1995.

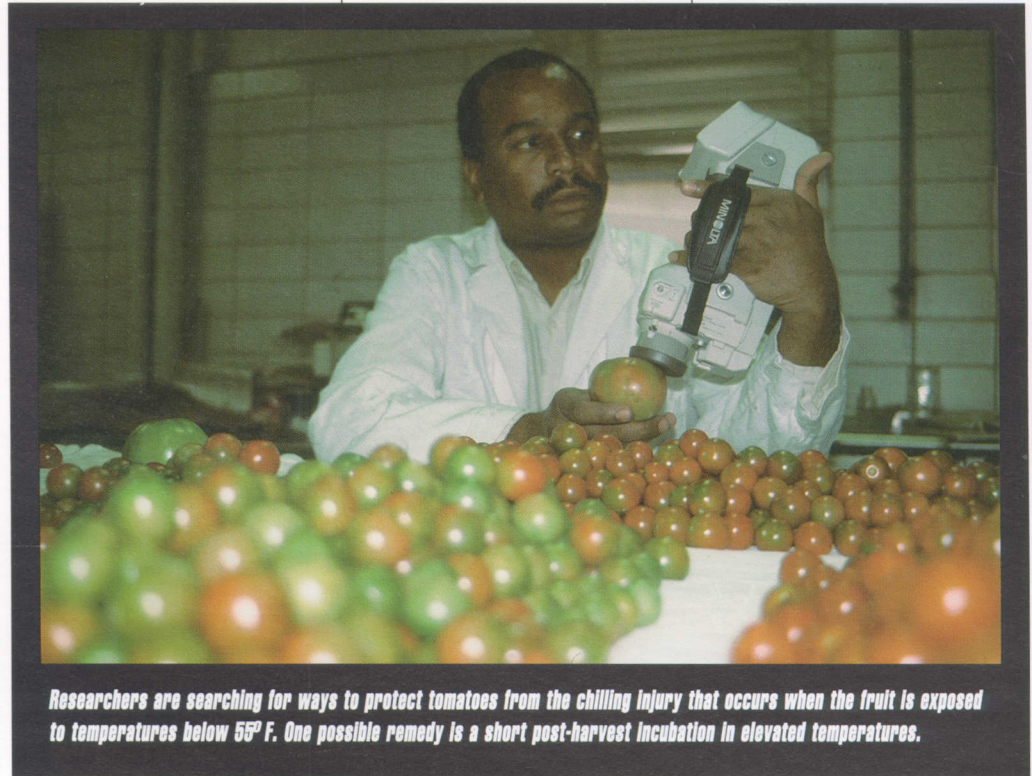
growth habit that allows easier harvest. Genegreen has an attractive green seedcoat that it retains after it dries.

LEARNING HOW TOMATOES RESPOND TO HEAT, COLD

AAES botanists and horticulturists have discovered that elevated temperature can delay the ripening of tomatoes by about a week. Temperatures of 90-94°F cause heat shock which inhibits the synthesis of enzymes that make tomatoes change color, produce sugar, and become soft.

The next step is to determine if this knowledge can be used in commercial applications. Possible advantages include reduced shipping expenses and improved winter production of tomatoes.

In a related study, researchers are examining a possible relationship between the heat shock response and the protection of tomatoes from chilling injury, which occurs when temperatures drop below 55°F. They are



Researchers are searching for ways to protect tomatoes from the chilling injury that occurs when the fruit is exposed to temperatures below 55°F. One possible remedy is a short post-harvest incubation in elevated temperatures.

investigating the potential of using short post-harvest incubations of tomatoes in elevated temperatures to protect the fruit from chilling injury.

DNA FINGERPRINTING FOR FOOD SAFETY

"DNA fingerprinting" techniques, used successfully to snare criminals, are being developed by AAES microbiologists to track water-borne bacteria that cause disease in humans and commercial catfish populations.

DNA fingerprinting can detect and help identify the source of food contamination and fish disease, which aids in avoiding the problems. The techniques are more sensitive than classical methods and can be performed in less time. Many bacteria seem identical, but these techniques can

AAES CAPSULE

SHADE TREE BOOK

AAES ornamental horticulturists recently published a valuable reference manual for landscapers, nursery producers, master gardeners, urban foresters, garden center owners, or anyone who enjoys

trees. *Shade Trees for the Southeastern United States: An Auburn University Evaluation* presents in-depth information about more than 60 native and exotic trees and explains how they performed

over the past 13 years in the AU Shade Tree Evaluation at the AAES Piedmont Substation in Camp Hill. Facts on growth rates, fall color, flowers, and other desirable features, as well as limitations,

for each tree are included. About 200 color photos illustrate these attributes in the 133-page book, which is available at the AAES Office of Research Information for \$10.



A researcher prepares culture dishes of *Escherichia coli* O157:H7 for studies to determine the heat tolerance of the bacteria, which is responsible for several fatal food-borne disease outbreaks.

ENSURING NUTRITIONAL QUALITY OF FOODS

AAES food scientists are working to ensure the nutritional value of food products. In one project, researchers are analyzing the nutritional content of deli products for a major Alabama-based grocery store chain.

Nutrient analyses are performed for products such as potato salad, cole slaw, and various entrees. In an effort to provide deli items for health-conscious consumers, this information will be used to develop labels for the products. Auburn experts also are providing advice on ways to improve the nutritional quality of some deli foods.

In other research to benefit Alabama consumers, AAES food scientists are developing improved methods for detecting low-level adulteration and substitution in meat products. State inspectors need a convenient and reliable regulatory tool, but commercially available test kits are very expensive, and other traditional methods are time consuming and subject to various limitations.

Researchers are developing tests based on "monoclonal antibodies," which are molecular tools tailored to seek out specific antigens in a given meat species. One goal is to identify heat-stable antigens and develop monoclonal antibodies for use in testing cooked

detect minuscule differences, often revealing dozens of subtypes — some more pathogenic than others.

Researchers are developing methods to detect *Edwardsiella tarda*, which affects catfish and humans, and *E. ictaluri*, which is pathogenic to catfish. Tests also are being developed for bacteria often found in seafood -- *Listeria monocytogenes*, which can cause meningitis or abortions; and *Vibrio vulnificus*, which can cause intestinal disease.

CONTROLLING E. COLI CONTAMINATION

Escherichia coli O157:H7 has caused several food-borne disease outbreaks, the most highly publicized of which occurred when a fast-food chain sold under-cooked hamburgers. AAES poultry and meat scientists are studying temperature tolerance of *E. coli* to provide better guidelines for handling and cooking meats.

Researchers tested *E. coli*-inoculated ground chicken, turkey, beef, and pork, including AU Lean products. They found that fat

helps the bacteria survive. AU Lean products, which have reduced fat, required less cooking time. Also, poultry products had a better kill rate at lower temperatures. In general, researchers found that 140°F for 2-3 minutes is sufficient to kill *E. coli*.

In a related study, researchers found bacteria still surviving on inoculated meat after five weeks of refrigerator storage. Some were found after 18 months in freezer storage.

meat products. Researchers must develop usable antibodies specific to each meat species. They are now developing monoclonal antibodies to detect pork.

IMPROVING INFANT FORMULAS

Infant formulas do not contain all the essential fatty acids found in breast milk, but full-term babies are believed to be able to convert other formula nutrients into the needed fats. However, premature babies may not have the enzymes necessary to make this conversion, possibly resulting in subtle effects on brain and eye development.

Some companies are trying to make formulas closer to breast milk by adding supplements of the essential fats. AAES nutrition experts are evaluating the effects of such enhanced formulas on the development of newborn pigs, which are physiologically similar to human infants.

Their research has yielded information on which

combination of fatty acid supplements closely simulates the benefits of breast milk without impacting on other growth variables. Research is continuing in an effort to identify new fat supplements.

NUTRITIONAL QUALITY OF BABY FOOD

AAES food scientists were among the first to quantify the concentrations in baby food of a nutrient that can be fatal to infants with a rare metabolic disorder. Galactose, a sugar, must be converted into glucose for the body to use, but some infants cannot produce the enzyme needed to metabolize galactose.

Galactose was once thought to be found only in milk, but a private laboratory recently found it in fruits and vegetables. For the one child out of 50,000 born without the ability to metabolize galactose, the nutrient builds up in brain tissue, causing stunted growth, mental retardation, and possibly death. This



Food scientists are developing methods to detect accidental or intentional substitution of ingredients in raw and cooked meat products.

disorder can be controlled with restricted diets.

To aid in planning such diets, researchers analyzed galactose content in commonly available baby foods and fruit juices. Extremely

small amounts were found in most products. All applesauce products were high in galactose, as were some squash and creamed spinach products.

AAES CAPSULE

PRIVATE FOREST RIGHTS

Perhaps the most hotly debated issue in forest management is the tradeoff between environmental protection and private property rights. In an AAES survey of Alabamians, including forest

owners, 84% agreed property rights are important, but only if they do not hurt the environment. A majority supported government regulations to protect the environment, but most also supported

compensation for forest owners when regulations cause economic loss. Seventy-two percent agreed that trees are like other crops that are cut and replanted to provide consumer products. But this ac-

ceptance was conditional upon the lack of adverse environmental effects. Only 33% agreed with chemical weed control, but the survey indicated widespread misunderstanding about the practice.

Dixon Center Crucial in Many AAES Studies



The Solon Dixon Forestry Education Center's 5,000 wooded acres near Andalusia offer a perfect setting for AU wildlife studies and other research.

The Solon Dixon Forestry Education Center, located near Andalusia, is perhaps best known for the practical field experience it has provided Auburn forestry students since 1980, but in recent years its 5,000 acres of timberland have proved invaluable in forest regeneration, pecan production, and wildlife research projects sponsored by the AAES and other agencies.

Much of the AAES forestry research will benefit the 220,000 nonindustrial private forest owners who control most of the upland forest acreage in Alabama. Researchers are evaluating low-cost, low-input mixed pine-hardwood forest

regeneration methods that not only meet management goals and maintain site productivity, but also preserve the beauty, wildlife, and environment of privately owned timberland.

In one study, researchers compared the ecological consequences of several pine-hardwood regeneration techniques. Of particular interest were methods that maintain organic debris, minimize soil movement, or stimulate rapid re-vegetation on the harvest site, factors critical to erosion prevention, nutrient availability, and reduction of silt flowing into nearby streams.

Regeneration methods included clearfell-and-burn, in which all remaining

vegetation is cut back and burned before pine seedlings are planted; clearcut-and-plant, in which vegetation is cut but not burned before pine seedlings are planted; and seed-tree, in which several large pines are left to reseed the area, and prescribed burning is not used. In addition, some plots were applied with a herbicide sold under the trade name Oust to better control crop tree density.

All methods were very effective at regenerating mixed pine-hardwood forests, but the

clearfell-and-burn method produced the greatest pine component, followed by the seed-tree method. However, the clearfell-and-burn technique resulted in less organic cover and a greater potential for erosion.

In one phase of the study, researchers examined the effects of regeneration techniques on diversity of the grasses and forbs (broadleaf plants such as the goldenrod) that grow after clear cutting. Diversity is vital in maintaining forest aesthetics, as well as providing wildlife habitats, protecting rare plants, and ensuring water quality. Results indicated that the clearfell-and-burn method without the herbicide promoted the greatest

diversity. Herbicide-treated sites with seed-trees were the least diverse.

A long-term study is underway to examine forest regrowth over the years after the various harvest and regeneration methods are used.

In addition to its pine and hardwood forests, the Dixon Center also includes AU's largest continuous pecan orchard, a 130-acre plantation of 80-year-old trees. The orchard includes blocks of the Southeast's three major pecan varieties — Schley, Stewart, and Success. Auburn horticulture researchers use the orchard in various studies, including insecticide trials and an investigation of the effects of chemical sprays on pecan tree pollination.

One study nearing completion tests the economics and effectiveness of using the ground-applied pesticide Aldicarb to control aphids and mites on pecan trees. Preliminary results indicate that the best returns above the cost of using Aldicarb can be attained from a single late-season application.

The Dixon Center's wooded acres are also ideal for wildlife studies. AAES wildlife scientists established one of the region's most successful breeding colonies of indigo snakes at the center in an ongoing effort to preserve the threatened reptile. Other AAES researchers addressed the concern that forestry practices are removing gray squirrel



One major project at the Dixon Center tests the effects of various forest regeneration practices on fragile ecosystems such as this wetland area. The ultimate goal is to develop low-cost, low-input forest regeneration methods that meet management goals while preserving the beauty, wildlife, and environment of timberland.

habitats. They showed that artificial nest boxes increased squirrel populations in young mixed pine-hardwood areas.

In response to concern

about perceived declines in numbers of songbirds, the Dixon Center is surveying bird species abundance during spring and fall

migration periods, the spring and summer breeding period, and winter in nine different forest types. During the 1993 breeding season, 57 different

species were surveyed, 31 of them in early-stage pine plantations. The study will continue in this year.

AAES CAPSULE

MAKING WASTE A RESOURCE

AAES and Tennessee Valley Authority researchers are developing technology to convert newsprint, wood, cardboard, and yard waste into a material that can be used to manufacture a 100%

biodegradable plastic. Recently, a fully biodegradable plastic was manufactured from lactic acid and approved by the Food and Drug Administration. Researchers are using bacterial

cultures to break solid wastes down into simple sugars and convert them to lactic acid. Such a technique not only could turn more than 100 million tons of municipal solid waste into a

valuable resource, it could spur the development of a product to replace some of the 15 million tons of non-biodegradable plastic used in the U.S. every year.

GENE GUNS, LASERS, AND SATELLITES: High-Tech Equipment Used in AAES Research

Mention agricultural and forestry research to many people and they are likely to have a mental image of tractors, chainsaws, and cattle chutes. However, modern research in these areas is more likely to involve an array of high-tech equipment.

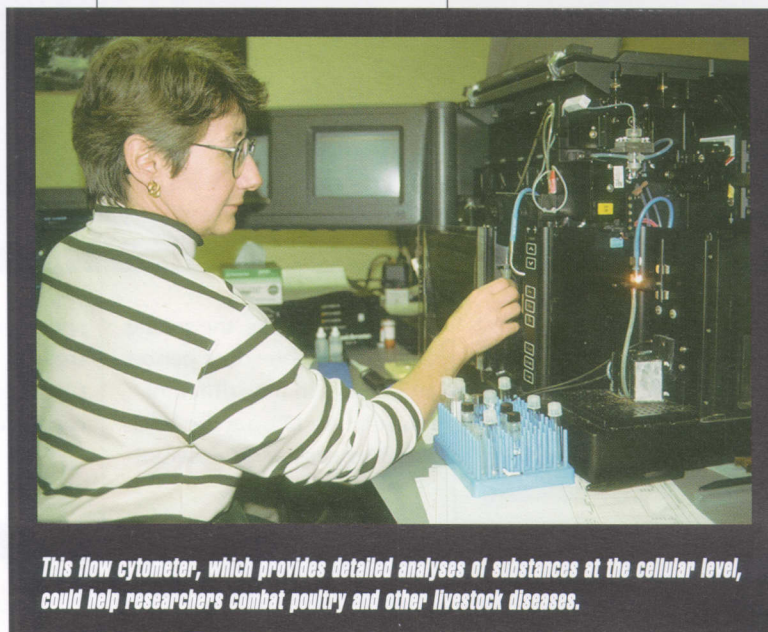
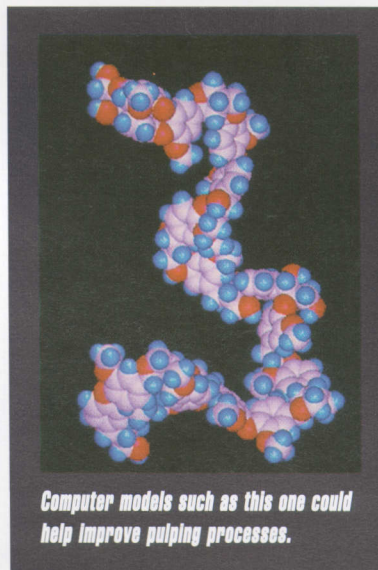
AAES researchers use a variety of state-of-the-art devices or innovative approaches to confront problems faced by agriculture, the forest industry, and the citizens of Alabama. Satellite technology, laser devices, sophisticated computers, and advanced medical equipment all are part of Auburn's research arsenal.

GENE GUN USED TO TRANSFORM PLANTS

AAES molecular biologists are using a novel genetic engineering technique to transform plant cells by blasting foreign DNA into them with a high-velocity "gene gun." The device allows researchers to perform genetic engineering experi-

ments not possible with traditional techniques.

Tungsten or gold particles are coated with foreign genes and applied onto a teflon cylinder which is inserted into the barrel of the gene gun. A .22 caliber bullet is used to accelerate the particles into a partially evacuated chamber containing a plant sample, causing them to strike with such force that the foreign genes enter into different cell compartments.



The gene gun is used in many efforts, including nuclear and chloroplast transformation to develop crops resistant to insects, herbicides, salt, and drought; genetic engineering of plants to express antimicrobial proteins; and genetic engi-

neering to develop tobacco plants that produce biodegradable plastic.

ULTRASOUND USED TO ENHANCE RIBEYE STEAK PRODUCTION

AAES animal scientists are using ultrasound to identify large ribeye-produc-

ing cattle for use in a selective breeding program designed to pass along the positive muscling trait.

Calves from these elite cattle are examined to determine how accurate ultrasound is at predicting ribeye-producing ability. Preliminary results show promise that ultrasound can be used to select cattle that are genetically prone to have larger ribeyes.

Ultrasound is the best method to measure carcass characteristics without slaughtering the animal. An ultrasound probe is placed on an animal's back to measure the amount of ribeye muscle and backfat.

CELL SORTER USED IN CHICKEN DISEASE STUDY

Poultry scientists are using a high-tech "cell sorter" to study the region of a chicken chromosome that controls disease resistance. Researchers are looking at AU-bred chickens with increased resistance to Marek's Disease to determine what factors account for the birds' enhanced immune system.

The cell sorter, or flow cytometer, uses a laser beam to analyze fluorescent properties of cells as they flow through the device. A computer isolates and analyzes cells of interest. One goal is to localize which genes account for the difference in disease resistance.

Understanding how the immune system works will



Agricultural engineers are using the U.S. satellite global positioning system to track the performance of forest machines. A researcher is shown testing a GPS receiver. The inset image shows the path of a skidder during herbicide spraying.

dimensional molecular images of lignin, a complex chemical that binds wood and must be removed to make paper. Researchers can analyze the electrical charge and shape of lignin structures, along with experimental pulping and bleaching chemicals.

Such studies can indicate which pulping and bleaching chemicals best react with lignin. One goal is to evaluate or develop more environmentally benign organic compounds that can be economically used in the papermaking process.

USING SATELLITES TO IMPROVE FORESTRY

AAES agricultural engineers and foresters are assessing the effectiveness of using the satellite global positioning system (GPS) to track and help measure the performance of forest machines. Research indicates that GPS can be a valuable management or engineering tool under some conditions.

A GPS receiver is

eventually help scientists identify solutions to disease problems. For example, information from the Auburn study could help in design of new vaccines.

COMPUTER MODELING TO IMPROVE PAPER

AAES wood chemists are using a computer modeling system to analyze the molecular structure and

chemistry of wood in studies that could lead to more efficient pulping processes and reduced pollution.

Computer-assisted chemistry provides three-

AAES CAPSULE

DOGWOOD DISEASE

An AAES survey of state parks and national forests in Alabama indicates dogwood anthracnose, a destructive disease of flowering dogwoods, has spread southward into the state. The disease

threatens the health and beauty of flowering dogwoods in forested upland areas of Northwest Alabama, and extensive tree death is expected in some areas. Few healthy trees were seen in

Monte Santo and Desoto state parks, and scattered damage was seen in many other parks. Spread of dogwood anthracnose into forested areas at elevations down to 600 feet indicates that damage may

eventually occur over wider areas of Alabama, including home landscapes. The disease causes leaf spot and blight and is most prevalent in shaded areas.

mounted on the forest machine to interpret microwave signals from Department of Defense satellites, tracking the location and elevation of the machine. The receiver can be linked to a data acquisition system to collect such information as machine velocity, status, and performance.

Performance information collected with the aid of GPS could be used to improve forest machine designs. It also could help determine the impact of forest machines on the environment and the accuracy of tasks such as herbicide spraying.



Molecular biologists are using a gene gun to blast foreign DNA into plant tissue, a procedure that allows them to perform genetic engineering studies not possible with traditional techniques. A tobacco leaf (Inset) is shown after it was bombarded by the device.

3-D PHOTOS FROM A WEATHER BALLOON

Measurements of young forest vegetation from ground level can be subjective and time consuming, while evaluations from helicopters are often too costly. Forestry researchers have developed a valuable alternative — a system of shooting three-dimensional photos from a low-level weather balloon.

A Forestry Canada balloon carries a lightweight aluminum boom with two 35mm cameras that are remotely triggered by radio control. The balloon can rise on a tether up to about 33

feet, where the cameras shoot photos from slightly different perspectives. A stereoscope is later used to provide a 3-D view of the trees and undergrowth capture on the photos.

From the 3-D images, researchers can measure tree height, crown area, percent cover of herbaceous growth, and other factors important to forest management. Photo measurements were similar to ground-based measurements in terms of accuracy and precision.

ENVIRONMENTAL CHAMBERS USED IN CO₂ STUDIES

Understanding how increasing carbon dioxide concentrations influence plant communities is important to Alabama's forest industry. Special environmental chambers at the U.S. Department of Agriculture National Soil Dynamics Laboratory, based on the AU campus, are helping USDA and AAES researchers answer important CO₂ questions.

The chambers — cylindrical aluminum frames covered by clear plastic film — generate large-scale, computer-controlled test atmospheres that are continu-

ously monitored via an infrared CO₂ analyzer. Plants grown in the chambers are exposed to twice the ambient concentration of CO₂.

In one study, sorghum and soybeans are grown to determine what plants do with the extra CO₂ and to examine effects of higher CO₂ on root growth and other belowground processes. First-year results indicated that CO₂ enrichment increased growth and yield of both species. A study with longleaf pine examines the interacting effects of elevated CO₂ and resource availability on carbon allocation patterns, respiration, and root function.

ROOT SYSTEM STUDIES BY ENDOSCOPE

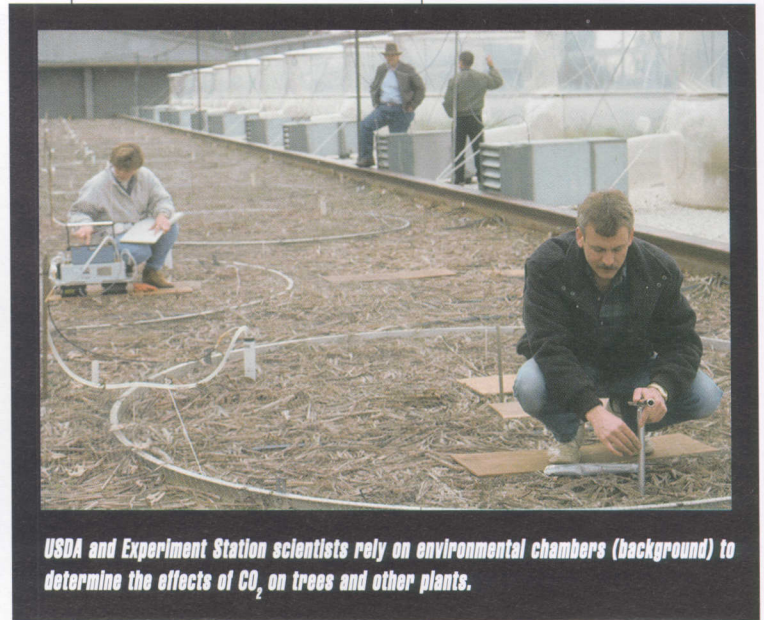
AAES foresters are using a nondestructive technique to study root systems in regenerating forests. Plexiglass tubes were placed in the ground throughout a harvested site to provide access points for a special endoscope, an optical instrument used in medicine for viewing the interior of a hollow organ.



Foresters use a specially adapted endoscope to study forest root systems.

Researchers are making long-term assessments of pine, hardwood, and herbaceous plant roots as they develop. The endoscope can be inserted up to one meter underground in the 108 tubes to provide video images of the root systems.

One goal is to determine how vegetative composition affects water quality. Killing hardwoods, grasses, and weeds helps pines grow faster, but plentiful roots help keep nitrates from reaching ground water. Pine-only plots were shown to have low root densities, but grasses and weeds increase root density throughout the soil profile. Hardwoods intercept more water, which is good for water



USDA and Experiment Station scientists rely on environmental chambers (background) to determine the effects of CO₂ on trees and other plants.

quality but could affect water availability.

ELECTRONIC MONITORING OF COCKROACH HABITATS

AAES entomologists used a unique simulation of smokybrown cockroach habitats to find clues for controlling the pest. They found that pine straw provides the most favorable climate for the insect because it maintains soil moisture,

insulates the soil from summer heat, and provides good hiding places.

Researchers placed various ground covers around simulated houses. Light intensity, temperature, and soil moisture — important factors in cockroach habitats — were recorded with electronic sensors installed at the soil surface of each plot. Measurements were taken hourly for two years by a computer.

AAES CAPSULE

RANKING ENVIRONMENTAL PROBLEMS

A survey by AAES fisheries scientists and rural sociologists revealed that Alabamians seem to have very different environmental views than those of technical experts. Respondents in a statewide telephone sur-

vey ranked the more cosmetic problem of litter as Alabama's greatest environmental risk, whereas contaminated drinking water, air pollution, industrial waste water, and hazardous waste were ranked 9th, 10th,

11th, and 12th, respectively, in a list of 25 environmental problems. These findings indicated a need for the public to become better informed about the relative seriousness of the environmental problems facing Ala-

bama today. The study was initiated by the Alabama Department of Environmental Management, which conducted a parallel study in which technical experts ranked the same 25 environmental risks.

Entomologists calculated the percentage of time when factors were favorable to cockroaches for each ground cover. Pine straw provided a favorable climate 75% of the time, followed by thatched grass (70%), dethatched grass (68%), garden stones (65%), blue rug juniper (61%), and bare soil (45%).

ELECTRONIC SURVEILLANCE OF WILDLIFE

Scientists with the AAES and Alabama Cooperative Wildlife Research Unit are using innovative electronic devices to study wild game and threatened animals in Alabama and elsewhere in the Southeast. Miniature radio transmitters and specially adapted camera equipment allow the researchers to discover information important in managing turkeys and quail, as well as reestablishing threatened animals such as the gopher tortoise and indigo snake.

By placing hundreds of

tiny radio transmitters on hen turkeys and poults, researchers found that young birds are lost to predators during the first month after hatching at a rate of up to 70% in Alabama and up to 90% in South Georgia and North Florida. Whether they were in the stomach of an alligator or a raptor's hollow-tree nest, the transmitters could be tracked to provide clues about the fates of the young birds. Raccoons, dogs, and foxes were identified as the top predators of young turkeys. In a similar study with quail, researchers found that rising raccoon populations in some areas are causing problems on quail reserves.

Wildlife specialists also adapted a closed-circuit television camera — originally designed for underwater nuclear reactor inspection — to examine the underground dens of gopher tortoises and indigo snakes. The camera, equipped with a fish-eye lens to permit observation of the entire



A special closed-circuit camera, originally designed for underwater nuclear reactor inspection, is used in studies of threatened reptiles.

burrow, is mounted at the end of a 36-foot steel cable. Lights encircle the lens, and the entire apparatus is covered with a protective glass globe. Linked with recording equipment at

ground level, the device is pushed down into the den. Such studies provided vital information about the reptiles' habitat requirements.

AAES CAPSULE

SURVIVAL OF RURAL RETAILERS

AAES consumer affairs researchers are conducting a five-year study with the goal of formulating merchandising, marketing, and management strategies to help rural retailers survive. Although retailers in

rural study sites identify potential growth from tourism, recreation, or retirees, they give little consideration to the retail possibilities of these options. Also, retailers are more likely to adjust strategies in relation to other

retailers rather than in relation to meeting customers' needs. Understanding consumer purchasing patterns can lead to better strategic planning and repositioning for individual businesses and a better definition of the

retail mix for communities. A survey of consumers is being conducted to determine shopping behavior, attitudes toward local merchants, and other factors.

Director's Research Awards

Winners of the 1993 AAES Director's Research Award were Brian Vaughn, a professor of family and child development in the School of Human Sciences, and Jim Cane, an associate professor of entomology in the College of Agriculture. The awards are given annually to recognize outstanding research accomplishments within the AAES. Vaughn and Cane each received \$10,000 grants to support their research programs, plus personal stipends.

Vaughn's work focuses on Alabama's most valuable of resources — its children. Vaughn is an internationally recognized expert in the area of children's social development. His AAES research focuses on regionalization of health care and the use of pre- and postnatal infant care in Alabama. His findings documented the probable reduction over the next decade in obstetric and pediatric services for women and infants in rural and non-urban counties and highlighted the dire consequences that could result when prenatal care is unavailable. Vaughn's survey has been



used extensively by state and national legislators and has been cited by colleagues throughout the world. A related project targets the mental health of rural Alabama children and their families.

Vaughn also is well known for his research in the areas of mother-infant attachment, peer relationships, and children's temperament. He recently received a \$470,000 grant from the U.S. Department of Health and Human Services to study the formation and maintenance of social structures in play-groups of young children in an effort to better understand the development of social



Brian Vaughn (above) documented that obstetric and pediatric services in rural areas are likely to decline. He is internationally known for his research on children's social development.

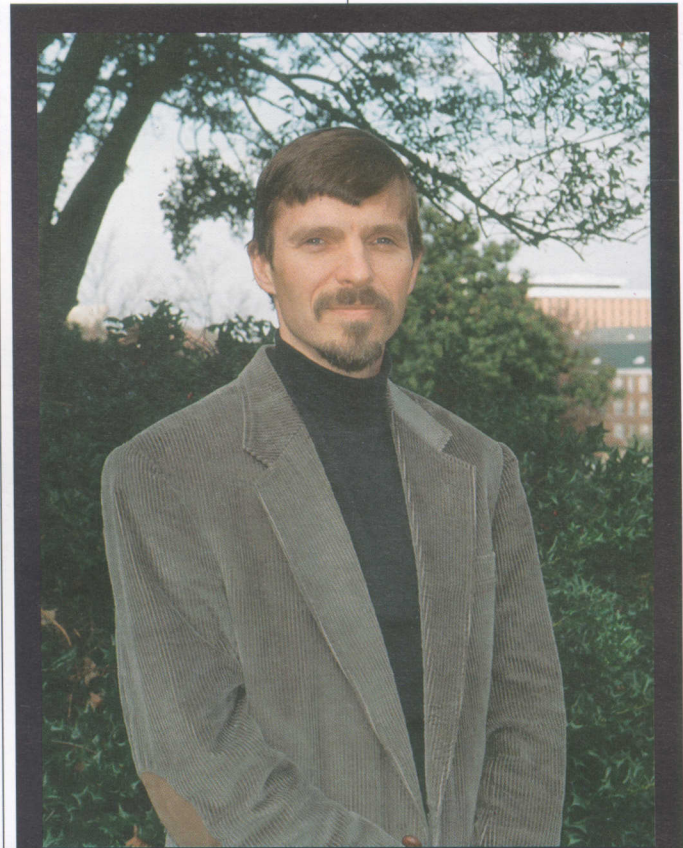
competence.

Cane's work is in a critical, yet often overlooked area of plant production, the relationship between insects and plants. Cane has studied the evolution of *Ips* bark beetles, which has an impact on Alabama's forest industry; and the relationship between foraging habits and pollination efficiency of bees, which affects crop production. One example of the impact of his work is his study of a solitary, ground-nesting bee, *Habropoda laboriosa*. Cane showed that this bee, now commonly called the blueberry bee, is vital for proper pollination and fruit set in rabbiteye blueberries, a common variety used in the Southeast. Cane's pioneering research also has drawn the attention of granting agencies, resulting in more than \$500,000 in competitive grants.

Vaughn received a bachelor's degree in psychology from Arizona State University and earned master's and doctoral degrees in child psychology from the University of Minnesota. Before coming to Auburn in 1988, Vaughn served as a post-doctoral fellow at the University of California-Los Angeles and as an associate professor in the Department of Psychology and the Institute for the Study of

Developmental Disabilities at the University of Illinois-Chicago.

Cane graduated summa cum laude, with a bachelor's degree in entomology from the State University of New York in 1977. In 1982, he earned the Ph.D with honors in entomology from the University of Kansas. During his graduate studies, he was a Fulbright Fellow, a Danforth Fellow, and a Fellow of Sverige-Amerika Stiftelsen. Cane was a post-doctoral fellow of the Miller Foundation at the University of California at Berkeley before joining the AU faculty in 1985.



Jim Cane (above) conducts pioneering research to better understand the relationship between insects and plants. His work with bees proved vital to blueberry production in the Southeast.

Financial Highlights

TOTAL REVENUES

STATE
\$16,452,596

STATE PAID EMPLOYEE
BENEFITS
\$1,886,742

FEDERAL
\$4,135,277

CONTRACTS AND
GRANTS
\$8,700,658

AUXILIARY REVENUES
\$4,038,083

CONTRACTS AND GRANTS

FEDERAL
\$4,465,413

STATE
\$1,027,515

PRIVATE
\$3,207,730

AUXILIARY REVENUES

SALE OF RESEARCH
PROJECTS
\$2,825,514

DIAGNOSTIC SERVICES
AND FEES
\$244,929

INTEREST AND
ROYALTIES
\$82,994

INDIRECT AND OTHER
COST RECOVERIES
\$884,646



Alabama Agricultural Experiment Station Report of Revenues for the
Fiscal Year Ending September 30, 1993

Alabama Agricultural Experiment Station System

Much of the research reported in this publication could not have been conducted without the support and participation of the outlying units of Auburn University's Alabama Agricultural Experiment Station. The E.V. Smith Research Center, 11 substations, four forestry units, and other units allow AU researchers to serve the needs of field crop, livestock, forestry, and horticultural producers in each region of Alabama. Every Alabamian has a stake in this research program, since any advantage realized from new and more economical agricultural techniques directly benefits the consuming public.

AAES RESEARCH UNITS:

☉ Main Agricultural Experiment Station, Auburn University.

☆ E.V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
7. Forestry Unit, Coosa County.
8. Piedmont Substation, Camp Hill.
9. Forestry Unit, Autauga County.
10. Prattville Experiment Field, Prattville.
11. Black Belt Substation, Marion Junction.
12. The Turnipseed-Ikenberry Place, Union Springs.
13. Lower Coastal Plain Substation, Camden.
14. Forestry Unit, Barbour County.
15. Monroeville Experiment Field, Monroeville.
16. Wiregrass Substation, Headland.
17. Brewton Experiment Field, Brewton.
18. Ornamental Horticulture Substation, Spring Hill.
19. Gulf Coast Substation, Fairhope.

