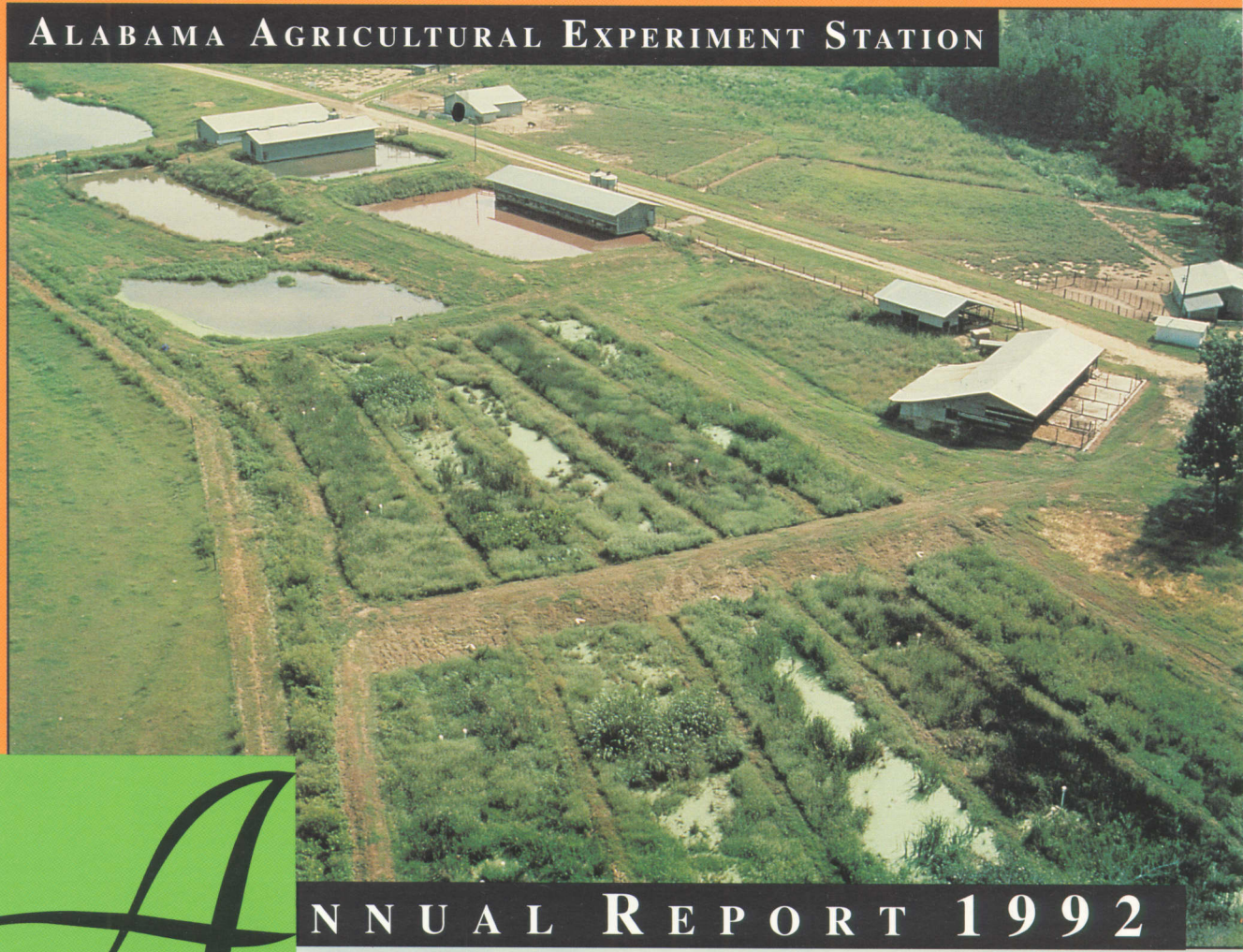
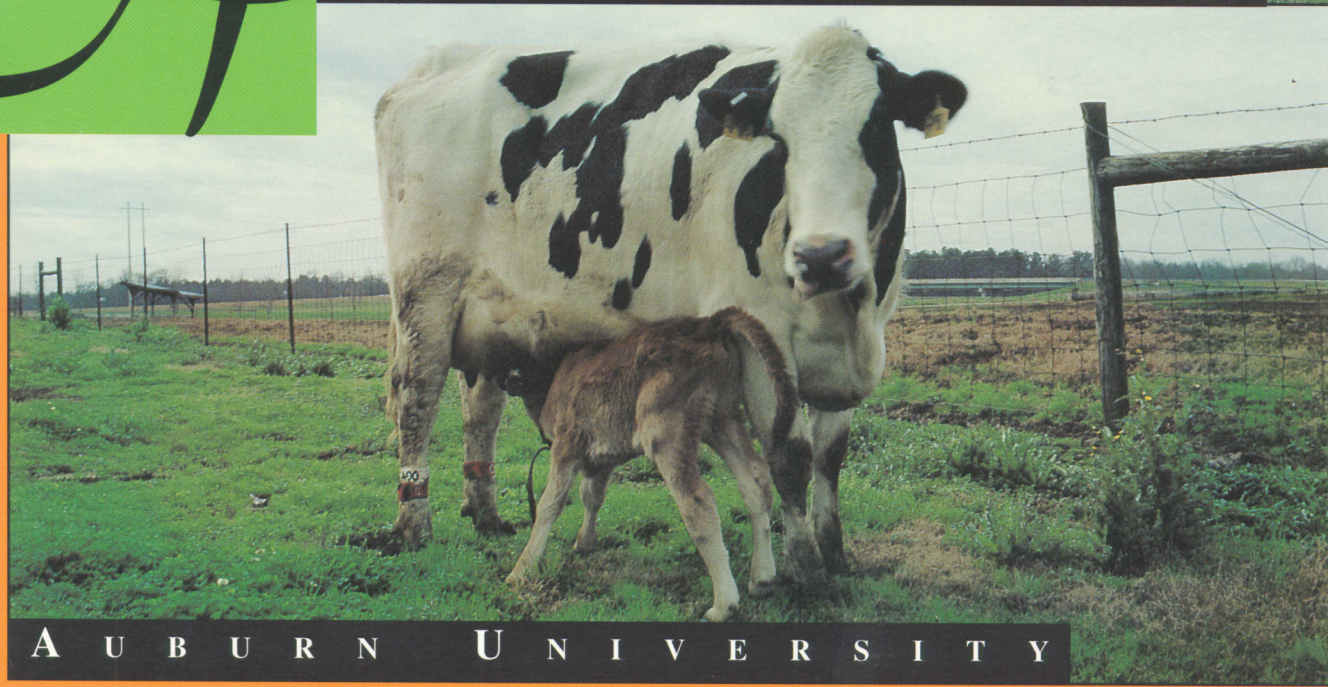
ALABAMA AGRICULTURAL EXPERIMENT STATION



ANNUAL REPORT 1992



AUBURN UNIVERSITY

On the cover:

Examples of two of the Experiment Station's innovative projects in 1992 are featured on the cover. In the top photo is an aerial view of experimental artificial wetlands used to filter waste water from a livestock production operation. The bottom photo is of Auburn's first test-tube calf, a Jersey bull that had been implanted as a fertilized egg into a Holstein cow using *in-vitro* fertilization. Both projects are featured in this annual report.

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FOREWORD

A sage once said, "the dictionary is the only place where success comes before work." This 1992 Annual Report presents results and successes of only a few research projects conducted by scientists working in the Alabama Agricultural Experiment Station. However, it is dedicated to all the faculty and staff who put team work before individual success, making 1992 a year of tremendous successes in the Experiment Station.

One of 1992's successes was the opening of the Plant Science Center, culminating several years of administrative work. The Center provides scientists with the latest in greenhouse environmental control, where climate is monitored and controlled by computer. This Center allows scientists to reliably and closely simulate field testing of plants before applying new techniques in actual field tests and then transferring the knowledge to growers.

When the term "hard work" is used in agriculture, one usually thinks of pulling weeds, working cattle, or some such physical labor. Although hard work is hardly out of vogue on the farm, computers and other labor saving devices are becoming standard management tools. Auburn scientists have developed and implemented computer programs that assist producers in making management decisions. A system to obtain weather data, plus historically-based weather predictions that can be used to make management decisions such as when to spray pesticides is near completion. In the future, computer programs will adjust the fertilizer, pesticide, or planting rate based on the soil type, pest intensity, or other production factors.

More than ever, concerns about maintaining and improving our environment must be considered when making management decisions. Likewise, when conducting research, scientists must consider the ecological impact new innovations will have, regardless of benefit to producers. Thus, environmental quality continues to be a high priority of Experiment Station research. Finding environmentally compatible uses for waste materials, thus converting them to resources, also is an important part of the Experiment Station research program.

Experiment Station research is also cognizant of consumer needs and concerns. When American agriculture moved from animal-drawn to mechanical cultivation and harvesting equipment, agricultural research was decades ahead of implementation. Likewise, when farmers turned from human labor to chemicals for pest control, research-proven technology was several years ahead of actual implementation. Unfortunately, the rapid changes in technology, coupled with level or reduced support for agricultural research, has dramatically reduced this lead time between technological breakthroughs and the utilization of new information by producers.

To be as successful as we have been in the past, the Experiment Station must continue to adapt to the growing requirement for quicker technology transfer, or it must secure the resources necessary to widen the window of opportunity for applying agricultural breakthroughs. Fortunately, we have the dedication of scientists, administrators, and support staff to do both, thus assuring success for Auburn University and the producers of Alabama.

Lowell T. Frobish, AAES Director

Harsh freezes virtually wiped out Alabama's once-thriving satsuma orange industry, but Auburn horticulturists are looking for new ways to protect the valuable crop and thereby revive citrus production in the State. This study is exemplary of the wide-ranging and innovative research program sponsored by the Experiment Station in 1992.

Innovations for Producers

One of the primary goals of Auburn University's Alabama Agricultural Experiment Station (AAES) is to develop innovations to benefit the State's producers of livestock, crops, and other commodities. These pages present but a few examples of the developments AAES researchers accomplished in 1992.

In one exciting area of research, a new management strategy designed by AAES animal scientists showed promise in increasing the number of pigs born, as well as enhancing their survivability, size, muscle mass, and performance. The procedure calls for injecting a natural growth hormone into gestating sows. A related project could yield equally dramatic results in cattle.

Co-sponsored by the Alabama Pork Producers association, researchers injected porcine somatotropin into sows when the embryonic muscles were developing. In preliminary studies, the procedure resulted in longer, healthier, more muscular, and possibly faster growing pigs. Preliminary data in a study using bovine somatotropin in cattle should be available within a year.

GOOD NEWS FOR CATTLE PRODUCERS

The Alabama Cattlemen's Association is supporting another area of research involving bovine somatotropin. In this project, animal scientists inject the growth hormone into cull cows in an effort to hydrate muscles and increase the yield and quality of lean meat from these animals. Now, cull cows are slaughtered for ground beef, but the new procedure provides the potential for enhancing the value of loins, ribs, or other muscle groups in old cattle.

This innovative technique — the first use of bovine somatotropin in cull cows — was successful in initial experiments in reducing fat deposition and increasing protein synthesis and deposition.

TEST-TUBE CALVES

Cattle producers also stand to benefit from veterinary medical research in the area of "*in vitro* fertilization" (IVF), or the production of test-tube calves.

When a cow is culled from a herd because of injury or illness, cattle producers lose both the animal and the genetic value of the calves she might have produced. Now, Experiment Station IVF research offers producers a way to salvage valuable genes. IVF is used to unite eggs and sperm in an artificial environment and then to implant the fertilized eggs into another cow that can carry the calf to term.

To date, four dairy cows have been impregnated with IVF calves. The first calf, a Jersey bull carried by a Holstein cow, was born in mid-January. The IVF technique is offered as a service to Alabama producers by Auburn veterinarians.

REVITALIZING THE OYSTER INDUSTRY

Auburn faculty helped make a breakthrough in 1992 that could revitalize the oyster

Working with industry, researchers at Auburn's Marine Extension and Research Center helped refine a system of off-bottom culturing of rapidly maturing premium oysters in Bon Secour Bay.

industry in Alabama. Working in cooperation with the AAES, Bon Secour Fisheries, a private company in Baldwin County, harvested its first crop of oysters grown off the bottom of the bay.

Auburn's Marine Extension and Research Center (AUMERC) and other State agencies worked with the company to improve upon a system of linking mesh bags and suspending them above the bottom of Bon Secour Bay with buoys. Tiny oysters were placed in small-meshed bags and then moved to increasingly larger-meshed bags as they matured.

Growing oysters off bottom allows faster and cleaner growth, both of which produce premium oysters. The oysters grew to marketable size in 15 months, but researchers hope to get that down to 12 months. It takes about two years for oysters to reach market size in the wild.

AUMERC provided water quality sampling and other technical expertise on the project. The marine center has several projects underway to revitalize the oyster industry, but this effort was the first to reach commercial application.

NEW AU LEAN PRODUCT

Developing new food products also remained a top priority in 1992. AAES meat scientists who made headlines with the development of AU Lean™ ground beef continued their efforts with the introduction of AU Lean sausage, which has 70 percent less fat and about half the calories of traditional pork sausage.

When cooked, AU Lean contains 9 percent fat, compared to 31 percent for traditional pork sausage. In addition to reduced fat, AU Lean sausage contains only 96 calories per two-ounce serving, compared to 210 calories for a comparable serving of traditional pork sausage. Also, it rated highly in two taste tests.

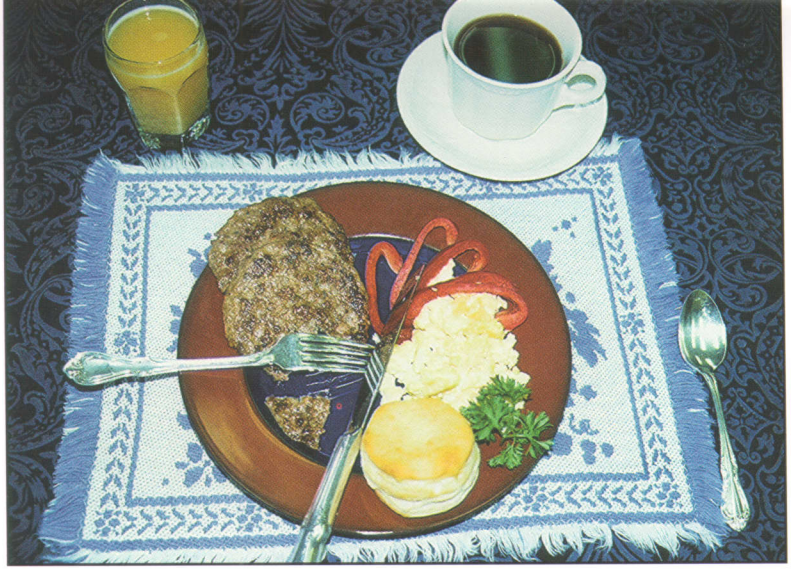
Several major grocers are planning to market the sausage in the Southeast and Northeast. Numerous other food chains, restaurants, and organizations also have expressed interest.

GENETICALLY IMPROVED MUSHROOMS

Another AAES breakthrough has the potential of providing the world a new high-protein food source. Auburn microbiologists successfully genetically engineered a commer-

AAES CAPSULE

CHEAPER SOURCE OF ETHANOL — Auburn researchers took a major step in 1992 toward finding a cheap, abundant source of ethanol for use as automobile fuel. Auburn scientists have found that switchgrass may be an ideal source of inexpensive material to produce ethanol, a fuel that is safer for the environment. Most ethanol is now made from corn grain and is so expensive it must be subsidized to make its price competitive with gasoline.



Development of the AU Lean family of low-fat meat products continued in 1992 with the introduction of a sausage containing 70 percent less fat.

cial variety of edible mushroom, and their new gene-splicing technique is likely the first step toward developing a new protein-rich food.

Perfecting this technique — the first genetic engineering of an edible mushroom — is the first step in improving the protein quality of mushrooms. The technique will allow researchers to splice genes into the oyster mushroom from other plant and animal sources, such as the seed storage proteins of legumes or egg-related proteins from poultry.

Researchers speculate that if mushrooms can be genetically improved for protein content, then the fungus might nutritionally and economically compete with traditional agricultural commodities. Mushrooms grow on agricultural byproducts, require little land, do not need sunlight, and are inexpensive to produce.

BETTER SALMONELLA DISINFECTANTS

Alabama's poultry industry could reap major benefits from research by AAES poultry scientists. Despite rigid health and safety precautions, it is estimated that up to 30 percent of the poultry that make it to market are contaminated with Salmonella, which can cause illness if meat is prepared improperly. However, a new test developed at Auburn could help lower this contamination significantly.

Poultry scientists have developed a new, more sensitive method for screening chemicals proposed for use in removing Salmonella bacteria from chicken carcasses.

Many compounds show great promise in laboratory tests but then exhibit little effectiveness in field trials. Traditional lab tests examine bacteria concentrations in the water used in chill and scald baths in poultry processing. However, Salmonella become imbedded in follicles in a chicken's skin and are able to survive most disinfectant treatments.

In an AAES project, scientists used chicken skin — which was first treated with gamma radiation to kill all native bacteria and then inoculated with pure Salmonella — to test existing chemicals and design new treatments. The new test, referred to as the Skin Attachment Model (SAM), provides a more accurate measure of the numbers of Salmonella actually killed by a proposed chemical treatment.

LUPINS RETURN TO ALABAMA

A group of Experiment Station and U.S. Department of Agriculture researchers launched a six-year project that could revolutionize cool-season production agriculture in the Southeast. With support from producer check-off funds administered by the Alabama Farmers Federation, they are working to establish winter-hardy white lupin as a viable crop in the region.

AAES CAPSULE

DNA FINGERPRINTING FOR MICROBES — Recent developments in the Mobile Bay area revealed that ships from South America sometimes carry epidemic strains of bacteria in their bilge water, possibly causing pollution of oyster beds. AAES microbiologists are using highly advanced methods of "DNA fingerprinting" in studies that could help detect and define these and other water-borne pathogens that can harm the State's aquaculture industry and cause disease in humans.

White lupin, which can be fed to livestock without processing and is valuable as a winter cover crop, has the potential to revolutionize production agriculture in the Southeast.

The legume crop produces a sweet, high-protein grain that can be crushed and fed to livestock without processing, giving it a big advantage over some other grains. Also, lupin grows on poor soil because it produces its own nitrogen, leaving up to 200 pounds of N per acre when grown as a cover crop.

Before the 1950s, up to 2.5 million acres of lupins were grown annually in Alabama. However, since the native lupin was bitter, it was grown only as a green manure or cover crop. Lupin is not grown at all now.

The Auburn-based multidisciplinary research team is evaluating exotic white lupin varieties and working to develop new varieties in stands from the Gulf Coast to the Tennessee Valley.

Alabama is a grain deficit state, but both the poultry and beef cattle industries are growing. Lupin could prove to be a valuable new feed source for livestock. Crop producers also could benefit by having a new winter cover crop that enriches soil with little input.

TESTING BIOENGINEERED COTTON

Alabama cotton producers could benefit from the effort of AAES agronomists who are testing a variety of cotton genetically transformed to tolerate applications of bromoxynil, a contact herbicide that kills normal cotton.

Experiment Station tests demonstrated that the transgenic cotton, developed by Calgene Labs in Davis, Calif., performed well under Alabama growing conditions when treated with two applications of bromoxynil, which was shown to control annual morningglory, velvetleaf, prickly sida, and some other weeds. The ability to use bromoxynil on cotton will provide a long-needed option for broadleaf weed control in this crop. Calgene anticipates full registration of the new cotton by 1994 or 1995.

SEEKING FROST-RESISTANT ORANGES

Satsuma oranges once were a thriving crop in the Gulf Coast, but harsh freezes in the region virtually wiped out the industry. Now AAES horticulturists are looking for new ways to protect satsuma trees from cold weather, thus revitalizing orange production in Alabama.

Auburn researchers are comparing various freeze protection methods, such as mounded soil around the trunk, water misting systems, and trunk wraps. Yields from warm years will be compared to yields during cold years to determine which treatments are most effective.

A mature satsuma tree can produce 10-15 bushels per year, and prices have averaged $30 to $50 per bushel. Some trees in the study site at the Gulf Coast Substation have yielded as much as 48 pounds of fruit.

AAES CAPSULE

NEW INSECT DISCOVERED — Some nursery managers report a 30 percent incidence of malformed, "bushy-topped" pine seedlings, and AAES foresters have found a new insect that may be responsible for much of this damage. *Taylorilygus pallidulus*, or T-bug, was found in the Southeastern U.S. and several other countries. Identification and subsequent control of the insect has dramatically reduced injury to pine seedlings worldwide.

Animal Research May Help AIDS Victims

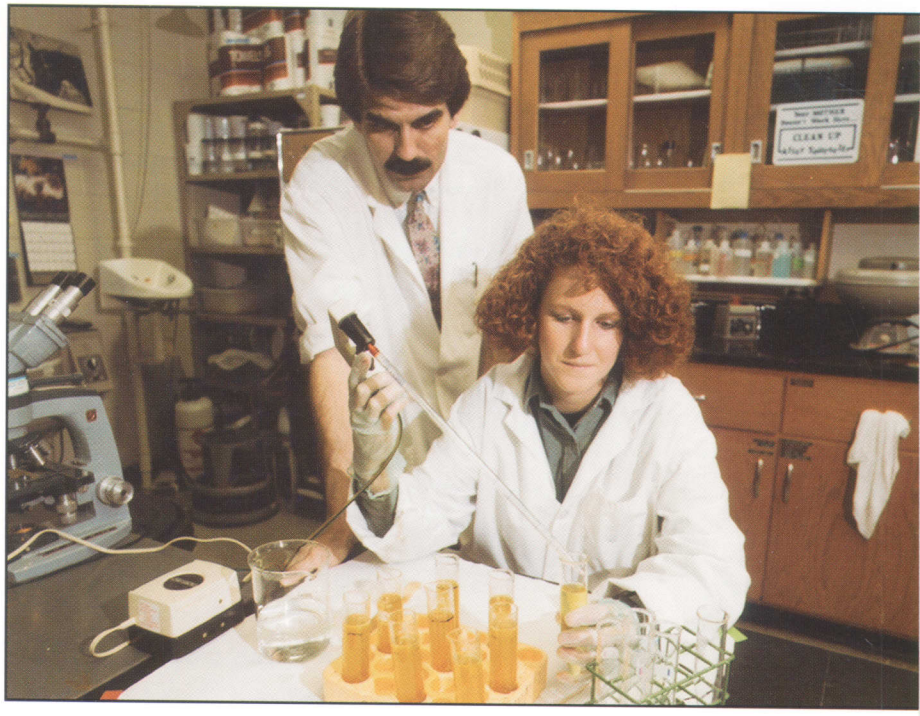
Researchers in the Experiment Station's animal health program have developed new chemical compounds to combat two parasitic diseases that not only affect food and companion animals but also are lethal for AIDS patients.

Cryptosporidium parvum affects cattle, and *Toxoplasma gondii* infects pigs, goats, and sheep. These parasites also are included in the AIDS-defining complex of opportunistic diseases. Auburn scientists developed three chemicals that inhibit the growth of *C. parvum* and one that inhibits *T. gondii*.

The breakthroughs were made possible by years of Experiment Station-supported research that led to the development of scientific models for examining the effects of various chemicals on the parasites. Innovative techniques were developed using neonatal mice and cell cultures, which serve as models for the development of cryptosporidiosis and toxoplasmosis in humans and food animals.

Using new models, researchers screened many experimental compounds before finding that Maduramycin, Alborixin, and Diclazuril inhibit *C. parvum*, and Diclazuril is effective against *toxoplasma*. Testing in humans or non-human primates must follow before the new chemicals can go into widespread usage for AIDS therapy.

While not fatal to most people, cryptosporidiosis can cause a fatal gastrointestinal flu-like illness in AIDS victims. About 5 percent of AIDS patients will have the disease, and those who do contract it have no way to fight it. The condition can kill the patients or weaken them so that other complications become fatal.



Auburn pathobiologist Byron Blagburn, standing, works with an Auburn veterinary student in a study of parasites that not only are harmful to some livestock but also can be lethal for AIDS victims.

Cryptosporidium has received increasing attention since it was first identified in humans in 1976. Much of the pioneering research done on the protozoa has been conducted at AU.

T. gondii can cause a severe encephalitis in AIDS patients. Also, the parasite can be transmitted to otherwise healthy people who eat undercooked pork or are exposed to the feces of infected animals.

Experiment Station researchers are continuing studies to define how the diseases develop and spread and to calculate the economic impact they have on the dairy, poultry, and other livestock industries. In a related area of research, Auburn scientists are developing a mutant strain of *toxoplasma* to use as a vaccine candidate for *toxoplasma* infection in pigs.

In addition to Experiment Station support, the research is funded by grants from the American Foundation for AIDS Research and the National Institute of Allergy and Infectious Diseases.

Protecting The Environment

Safeguarding Alabama's water resources, forests, wildlife, and overall environment has long been a goal of Experiment Station scientists, and research to better understand and control humankind's impact on nature continued in 1992.

One environmental concern tackled by dozens of AAES researchers is disposal of animal wastes, which can directly affect water quality, particularly in areas where livestock and poultry production are concentrated. Developing low cost, highly efficient waste management technologies is important in minimizing water quality problems while still promoting profitable agriculture.

CONSTRUCTED WETLANDS

In one innovative project, Auburn researchers are working with federal and State researchers to design and test artificial wetlands to filter waste water lagoons from a swine operation. Constructed wetlands are shallow, earthen detention ponds planted with aquatic plants, such as reed, bulrush, and cattail. The plants serve as attachment sites for microorganisms that aid in waste water treatment.

The constructed wetlands site, located at a 500-pig swine operation, contains two rows of five cells, each cell measuring approximately 26 X 162 feet. Nitrogen content of swine lagoon water discharged into the wetlands was reduced by 83 percent, and total phosphorous by 69 percent.

Assessing the threat posed by air pollution to hardwood forests is a

The project is a cooperative effort between the Experiment Station, Tennessee Valley Authority (TVA), USDA-Soil Conservation Service, and Alabama Department of Environmental Management.

or goal of AAES research.

TURNING A LIABILITY INTO A RESOURCE

A related concern is poultry production, which has grown approximately 50 percent in Alabama since 1986. Up to 4.5 million tons of litter are produced annually in Alabama alone. Broiler litter is a mixture of manure, feathers, and other wastes that collect on the floor of poultry houses.

One viable disposal option is to use litter as a fertilizer. In 1992, AAES agronomists evaluated it for use in fertilizing bermudagrass. Litter was shown to be as good or better than ammonium-nitrate amendments.

Other agronomy research showed that raising stocker cattle on litter-fertilized tall fescue can be economically competitive with producing row crops, reversing the opinion held by some that producing row crops is more profitable than beef enterprises.

Auburn horticulturists showed that a potting mix using composted litter was able to sustain growth of ornamental plants as well as or better than commercially produced media, and that it presented no substantial odor problems in the home. If widely used by the nursery industry, litter-based growth media could provide an economical alternative to potting soil ingredients that are often in short supply.

Agricultural engineers developed special spreaders for applying litter in forest plantations and will evaluate the fertilizing effect of the poultry byproduct on seedlings and on older trees at mid-rotation. If tree growth is enhanced, the project could yield yet another viable use for this valuable poultry byproduct.

WATER QUALITY RESEARCH

Water quality research is one of the Experiment Station's strongest programs. Pollution of groundwater is a growing environmental concern, yet predicting the pollution potential of landfills, lagoons, and land-applied chemicals is not easy because the process occurs underground, out of view. However, AAES agronomists, working with Auburn civil engineers, are providing new insights into this critical issue using new laboratory models.

The scientists and engineers developed models that simulate the movement of leachates as they percolate through the soil into aquifers. The researchers filled glass boxes with sand or beads to simulate soil profiles and the movement of leachates. With these models they can observe how contaminants trickle down in the

AAES CAPSULE

TRANSGENIC CATFISH — Further progress was made in 1992 on an AAES project to genetically engineer faster growing catfish. Laying the groundwork for this recent success was the earlier development of "transgenic" carp with growth rates enhanced by up to 40 percent. Now, Auburn fisheries scientists have successfully transferred the rainbow trout growth hormone gene into channel catfish. USDA gave Auburn permission in 1992 to test the new catfish in high-security outdoor ponds. So far, many of the fish, which contain only one foreign gene, have exhibited a 25 percent greater growth rate.

Auburn researchers have constructed and are testing artificial wetlands that show promise for filtering waste water from livestock operations.

different soil types and reach groundwater. Researchers also can monitor the chemical concentrations of leachates as they move through the soil. From this work, the Auburn scientists believe potential groundwater problems can be better predicted.

AAES fisheries experts have a wide ranging program to protect Alabama's water resources. In one recent study, Auburn researchers developed guidelines to help lake managers attain water quality levels that are acceptable to skiers and swimmers, but not detrimental to the State's $600 million sport fishing industry.

Regulatory agencies are attempting to reduce the amount of nutrients entering lakes to improve water quality, but lake management is a tradeoff between extremely clean water and greener water, which is better for sport fishing. Nutrients, such as phosphorus and nitrogen, which can come from waste water and some industrial effluent, increase the concentrations of algae, the base of a lake's food chain. However, high concentrations of algae can reduce the aesthetic value of a lake.

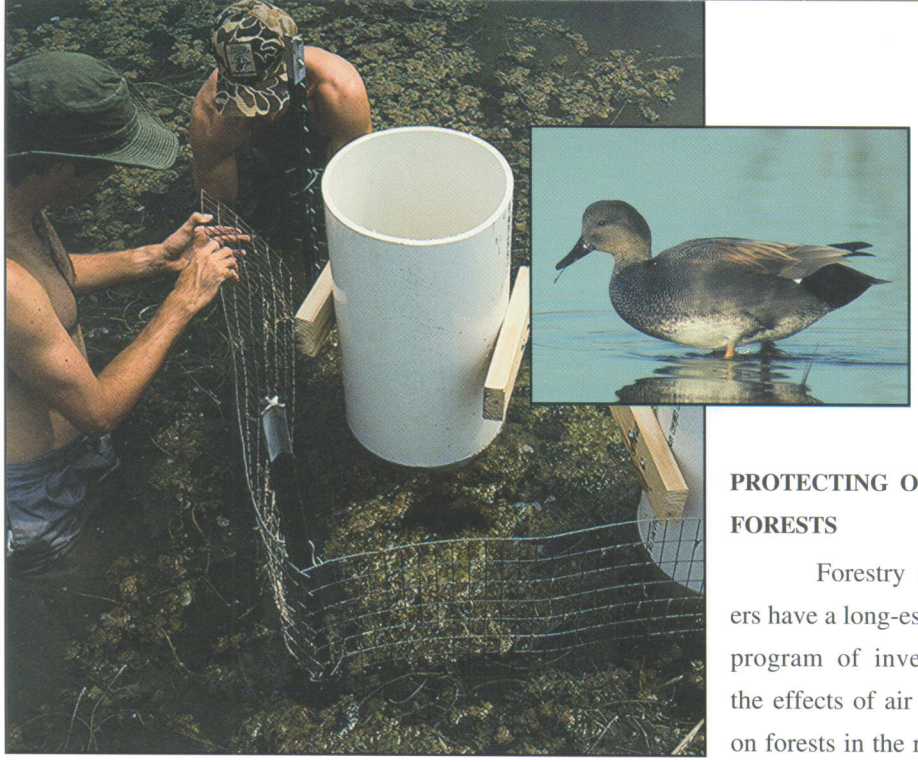
Researchers studied water quality and fish populations in lakes Martin, Jones Bluff, Eufaula, and Weiss to calculate the optimum concentrations of algae allowable for both good fishing and reasonable aesthetic quality. They found that reducing chlorophyll from extremely high concentrations to moderate concentrations may not harm bass and crappie fisheries. At the same time, improvements in water quality and clarity can be achieved. With these guidelines, many of the State's greener lakes can be cleaned without harming fish populations.

FINDING USES FOR SOLID WASTES

Old newspapers and other paper products represent about 30 to 40 percent of the debris in municipal solid waste systems. EPA has mandated a 25 percent reduction in solid waste disposal in landfills by 1995, with more dramatic reductions to follow. AAES-sponsored research could keep a great deal of scrap paper out of the nation's landfills by finding beneficial uses for it.

AAES CAPSULE

IMPROVING PHOTOSYNTHESIS — Basic microbiological findings by AAES researchers may one day be used to improve crop productivity by genetically enhancing photosynthesis, the process by which plants absorb energy from sunlight. Chloroplasts, the plant organelles responsible for photosynthesis, have a very complex genetic structure, but Auburn scientists made discoveries about how chloroplast DNA is copied and passed on to new cells. This finding and continuing AAES research could provide the tools for genetically engineering plants capable of more efficient photosynthesis.



Auburn students take samples from a hydrilla study site on Guntersville Reservoir in an investigation of how weed control measures affect gadwall ducks and other wildlife that depend on the lake.

In cooperative work with the U.S. Department of Agriculture's Agricultural Research Service, Auburn researchers found that applying ground newspaper in a trench next to rows of cotton increased cotton lint yields about 15 percent.

When ground newspaper was mixed with broiler litter and trenched near the plants, lint yields increased 60 percent, quadruple the increase resulting from applying litter alone. Also, ground newspaper was shown to reduce evaporation and soil erosion and to exhibit a herbicidal effect on grasses in the cotton.

Another use for recycled newspaper is being investigated by AAES poultry scientists. Researchers are testing a new type of chip made from recycled newsprint that can be used as a floor covering in poultry houses. Pine shavings are the traditional covering material but in recent years have become more expensive and in shorter supply. In AAES studies, chicks performed equally well on the new paper chips, which were developed by Advanced Material Technology, Inc.

PROTECTING OUR FORESTS

Forestry researchers have a long-established program of investigating the effects of air pollution on forests in the region. In recent studies, Auburn foresters joined U.S. Forest Service scientists to study air quality in the forests of Alabama, Florida, and Mississippi.

Trees and bushes on Mt. Cheaha in the Talladega National Forest were found to suffer greater damage from ozone pollution than similar plants in other national forests. Researchers attribute this finding to the fact that Cheaha lies in the Birmingham-Atlanta air shed. Ongoing studies also are under way in Alabama at the Sipsey Wilderness and sites near Ashland, Centerville, and Demopolis.

In related studies, Auburn foresters are examining effects of pollution on hardwood forests in the Great Smoky Mountains National Park. In 1992, researchers completed the first year of a study of visible ozone injury of trees in the park. More than 50 percent of the trees in study plots showed signs of ozone injury.

Other studies are in progress to investigate the effects of logging and road building on water quality and wildlife populations in forested wetland areas. Auburn has approximately $1 million in extramural funding for research in flood plain forestry.

AAES CAPSULE

VITAMIN C AND EXERCISE — In a study involving well-conditioned cyclists, AAES nutrition and food science experts found that while consuming 600 mg of vitamin C each day over a two-week period, the athletes had significantly lower heart rates during exercise than they experienced at the same workload when ingesting only 60 mg of vitamin C a day. Also, systolic blood pressure was found to be significantly lower 15 hours after exercise in the 600-mg phase of the study. These findings provide an important insight to nutrition and human performance.

Auburn forestry researchers are examining the effects of timber harvesting on wetland areas.

For example, AAES foresters are wrapping up a study on helicopter harvesting of timber from wetlands owned by Scott Paper Company in Monroe County. Under the specific set of conditions at the site, they found no water quality problems caused by aerial harvesting. However, these results may not apply to all wetland types, and approximately 95 percent of harvesting is still ground based.

WILDLIFE STUDIES

Zoologists and wildlife scientists at Auburn are involved in several studies to protect or enhance the populations of important game animals and endangered species in Alabama.

In one project, co-sponsored by TVA, Experiment Station scientists are examining the possible impact of aquatic weed control measures on water fowl and endangered bats that depend on the environment in and around Guntersville Reservoir.

Sterile grass carp were released into Alabama's largest lake to control the growth of the aquatic weed hydrilla. However, Guntersville is a major wintering habitat for ducks in the State, and it plays a major role in the ecology of two of the nation's largest colonies of endangered grey bats. Ducks eat the hydrilla, and bats live on the insect population that could be reduced if too much hydrilla is removed from the lake.

AAES wildlife experts are involved in a four-year study to determine the impact of grass carp on the ducks and bats. Carp must be restocked every 10 years, and the TVA will use the Auburn-generated information as a basis for determining whether to continue the weed control measure.

Blocks of recycled newspaper were shown to increase cotton yields 60 percent when trenched near the plants.

AAES CAPSULE

CATFISH ADVERTISING PAYS OFF — A study by AAES agricultural economists shows that the catfish industry's five-year, $1.5 million advertising campaign to increase awareness and consumption of catfish has been a good investment for producers. According to a survey, the campaign increased consumer awareness of catfish by 15 percent, consumer attitudes toward the fish by 3-6 percent, and at-home and restaurant purchases by 12-13 percent. Also, revenue increased by 8 percent at the wholesale level and 9.5 percent at the farm level. Each additional dollar of advertising was estimated to generate about $13 of additional producer surplus profit.

Improving Cotton Fabric Flame Retardants

AU textile chemists in 1992 began development of new, more efficient flame retardant finishes for cotton fabrics. The new compounds could greatly increase the service life of flame retardant finishes and decrease the risk of clothing catching fire.

A major problem with some existing flame retardants is that improper laundering can decrease their effectiveness. When washing clothes, consumers often do not follow proper procedures to maintain the flame retardant surface. Also, many existing finishes seep into a fabric and react with its internal structure, causing stiffness, loss of durability, or other problems.

Auburn's experimental approach is to create flame retardants containing micron or smaller sized polymer particles that bind only with the fabric's surface, thus eliminating the potential problems. Due to their chemical nature, the finishes are more wear resistant and harder to damage while laundering.

Since part of the finish is a polymer — or long chain of molecules with many reactive ends — more than one protective function could be included in one treatment. For example, a compound could be added to absorb pesticides or deactivate bacteriological agents. Because only one side of the fabric will be treated, the harmful substances would be trapped and unable to reach the skin.

When exposed to extreme heat, solid materials break down into gases that can ignite at high enough temperatures. Flame retardants change the way solid materials break down, decreasing the amount of combustible gaseous material released. However, existing flame retardants do not work under all the conditions in which they are needed.

With AAES support, Auburn textile chemist Ian Hardin is developing innovative new flame retardant compounds.

Knowledge and expertise gained in previous AAES-supported textile combustion studies led to the current effort to modify existing retardants or create new ones.

The work is one program of the National Textile Center - University Research Consortium, which Auburn and three other Southeastern universities established in 1992 with an $8 million grant from the U.S. Department of Commerce. The prototype flame retardants are being tested in collaboration with researchers at North Carolina State University, a National Textile Center partner.

Natural Weapons Combat Pests

Modern agriculture's high dependency on chemical pesticides can place a heavy burden on the environment, but a new institute at Auburn will help lessen this burden by providing natural, nonpolluting alternatives to control insects, weeds, and plant pathogens.

The Biological Control Institute (BCI), which includes entomologists, microbiologists, and plant pathologists, will seek natural weapons and processes to control plant pests. BCI's arsenal will rely on beneficial bacteria, fungi, or insects.

NEW BIOCONTROL INVENTIONS

Two new inventions by Auburn scientists exemplify the type of research that will be

As a member of the new Biological Control Institute, Auburn microbiologist Joe Shaw uses genetic engineering to augment the use of synthetic chemicals on crops.

A major part of Auburn's biological control effort relies on the use of beneficial predators, such as the earwig (inset), to control pests, such as the corn earworm.

fostered by the Institute. The new biocontrol systems promote the growth of beneficial microorganisms that attack diseases, weeds, or insects but are harmless to the crops themselves.

One invention, developed by an Experiment Station microbiologist, is an emulsifier designed for use in sprays using fungi that destroy weeds. Two patents were issued on the invention in 1990 and 1991, and a third one is pending.

The naturally occurring fungus used in one system is harmful to sicklepod, a weed that causes yield reductions in soybeans, cotton, peanuts, and other row crops. Spores from the fungi are placed in the emulsion, where emulsified droplets of water allow the fungus to germinate and infect the weeds. The emulsifier, which is sprayed on weeds using conventional pesticide equipment, is expected to work with most herbicidal fungi.

Auburn's other biocontrol invention, developed by AAES plant pathologists, helps sustain and grow beneficial microbial agents by providing a food source and helping them stick to leaf surfaces. This is the first significant system for biocontrol agents of foliage diseases. A major food company is conducting product development research using the system on tomatoes.

Chitin, cellulose, or other complex carbohydrates are mixed in the spray to feed the microorganisms. In addition to the food amendment, the formula includes a natural oil that acts as a varnish to anchor the food source to the leaf. The formula will not wash off with rain or irrigation water.

AAES research has found 50 to 300 percent increases of beneficial microbes on leaves treated with the new spray, which also is applied with conventional equipment. It has been adapted for use with 40-50 bacteria or fungi that provide various benefits, such as suppressing early blight on potatoes; leaf spot on peanuts; fly speck and sooty blotch on apples; and early blight disease, leaf spot, and bacterial spot on tomatoes.

AFLATOXIN CONTROL

In addition to ongoing work with the two inventions, AAES researchers are involved in a variety of other investigations to exploit beneficial bacteria and fungi. For example, plant

AAES CAPSULE

WHO DO YOU TRUST? — A survey of Alabamians by AAES rural sociologists revealed some interesting statistics about which sources people trust for valid information about the safety of farm chemicals. Overall, university professors were the most trusted, and the least trusted were advertisements. Less than 25 percent said they trusted civil servants or elected officials. Television documentaries also were highly trusted, especially by people under 30.

Auburn plant pathologist Sadik Tuzun uses a high-tech DNA synthesizer in his biological control studies.

AAES CAPSULE

DEER'S FAVORITE FOODS — Studies at the Auburn Deer Research Facility yielded results that can be used to develop planting regimes for whitetail deer management. Wildlife experts found that deer prefer small grains from November through February. Ryegrass and crimson clover also are favored during the cool months. In April and May, deer prefer ladino clovers. Red clover is preferred May-September. Soybean, velvetbean, and jointvetch also are favored at times during the hot months. Generally, forages are preferred when they are growing rapidly, relatively high in crude protein, and relatively low in fiber.

pathologists discovered a bacterial chitinase enzyme with anti-fungal properties that could be used to control fungi that produce aflatoxin, one of the most powerful natural carcinogens known.

Only 20 parts per billion of aflatoxin are allowed in U.S. crops, and there is presently no effective way to control the toxin-producing fungi in peanuts, corn, or other crops it contaminates. Aflatoxin-contaminated crops cannot be exported to Europe.

After screening hundreds of bacteria as possible sources of genes that control the production of chitinase — an enzyme that breaks down fungal cell walls — scientists found three microbes highly active against aflatoxin-producing fungi. They then isolated the DNA related to chitinase production. Using genetic engineering, the plant pathologists hope to transform plants to express the bacterial genetic material, allowing a plant to fight off infection by fungi that produce aflatoxin.

PUTTING BENEFICIAL MICROBES TO WORK

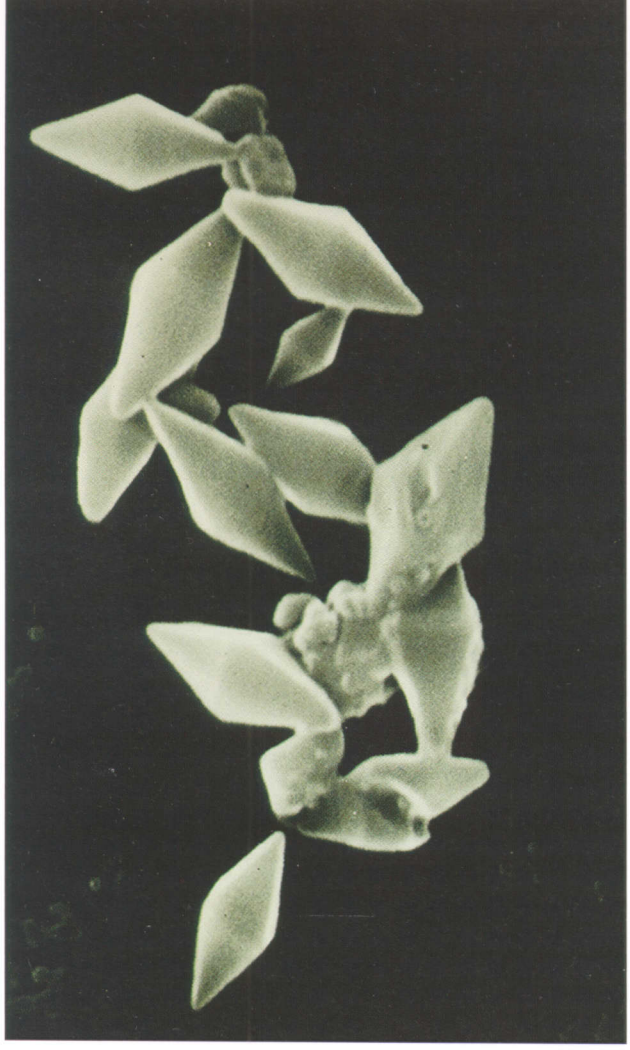
In other research, plant pathologists are using a nonpathogenic form of the bacterium that causes black rot to immunize cabbage against black rot disease. The beneficial microbe enters the surface of the cabbage through natural openings, immunizing the plant against the pathogen. Tests to date have demonstrated a 50-60 percent reduction in black rot.

In similar research, a penetrating surfactant system is being tested for use in a spray to control kudzu and other weeds. This version of the system uses microbes harmful to weeds but not to crops. Using the halo blight pathogen, researchers were able to kill most of the leaves in a field of kudzu.

Plant pathologists also developed a method of applying bacteria as a seed inoculant for disease control and growth promotion. The scientists use a strain of root-colonizing bacteria that produces an antifungal agent. After seed inoculation, the bacterium flourishes as the plants germinate. This biocontrol technique functioned as well as a chemical fungicide in controlling damping off of cotton seedlings in preliminary field trials.

NATURAL CONTROL OF INSECTS

Auburn's earliest biological control research was conducted in entomology, with studies dating back to the early 1900s, and the program remains active today. For example, AAES scientists released a parasitic wasp at the Wiregrass Substation in 1990 to control lesser cornstalk borers. An ongoing evaluation of the wasp, a native of Ecuador that kills other



These natural protein crystals, magnified by a scanning electron microscope, are one weapon Auburn entomologists are using against harmful insects.

insects by using its stinger to inject them with eggs, is under way.

Other entomological research is aimed at increasing the population of a native insect, known as the earwig, which is one of the most beneficial predators in Alabama peanut fields. Earwigs feed on all other insects, including the lesser cornstalk borer, corn earworm, and fall armyworm.

In AAES studies funded cooperatively by the Alabama Peanut Producers Association, researchers found that the earwig does not function well in hot, dry weather. Based on these findings, entomologists will test a theory that narrower row spacing — which provides shade to reduce evaporation and soil temperature — would increase the activity of earwigs.

Auburn entomologists also are searching for bacterial spores and proteins toxic to insects. These compounds are known as BT (short for "*Bacillus thuringiensis*") toxins. AAES researchers located BT toxins effective against the lesser cornstalk borer and the beet armyworm. Entomologists also have tested foliar sprays of BT toxins that kill pink bollworms and tobacco budworms, two common cotton pests.

The task now is to determine the best way to exploit this knowledge. One major goal is to develop a genetically engineered peanut plant that produces the BT toxin against cornstalk borers. The toxin genes have already been cloned into plant-associated bacteria in a collaboration between AAES entomologists and plant pathologists. This created a plant-colonizing bacteria that can kill insects.

Another entomological study is aimed at providing biological control of the greater wax moth, which can destroy honey combs. Auburn researchers are looking for techniques to attract and enhance populations of a naturally occurring wasp that feeds on the moth. Biocontrol is important in honey production, because consumers demand purity and reliability in this product.

Chemical insecticides can pose problems in the home, as well as in the field, prompting

AAES CAPSULE

SAVING FOR A DRY DAY — Increased demand for irrigation water in the Southeast is causing increased stress on many small streams where farmers are pumping directly from the stream. AAES agricultural engineers are investigating the feasibility of pumping during high stream flows, which occur during the winter, storing the water in off-stream reservoirs, and then distributing it for irrigation when water is scarce and competing uses are greatest. Researchers have completed an analysis of stream water availability and are now evaluating water storage reservoir costs and designs. Preliminary work has begun in the design and construction of a facility at the Tennessee Valley Substation in Belle Mina to test an experimental pumping, storage, and distribution system.

A graduate student sets up a protein gel in one of Auburn's biological control laboratories.

AAES CAPSULE

PRESERVING PLANT GENETICS — Improving crop productivity requires ongoing use of diverse plant germplasm. A goal of the National Plant Germplasm System is to preserve the original genetic variability of plants acquired and saved for future distribution. However, lack of information on the reproduction of 31 Vicia species could cause these plants to be lost. AAES agronomists are working with the Germplasm System to identify the reproductive processes of the Vicia, a genus that includes commercially important plants such as hairy vetch, broadbean, and fava-bean.

urban entomologists to look for biological control agents for one of the most common household pests — the German cockroach. They were successful in finding the first true biocontrol organism that is both practical and effective for German cockroach control.

In an AAES study, entomologists used nematodes, or tiny worm-like parasites, to provide an environmentally sound alternative to conventional insecticides. Nematodes were confined in moisture-retaining stations and placed in cockroach-infested apartments. The nematode stations performed as well as commercial insecticidal bait stations.

GENETICS IMPORTANT IN BIOCONTROL

Other biological control research in 1992 included the development by AAES microbiologists of a technique for genetically engineering a bacterium that can help some trees and shrubs take in nutrients from the air. The bacterium establishes a symbiotic relationship with the roots of trees and converts gaseous nitrogen into a form the plant can use as a source of nutrition.

The bacterium is associated with several woody plants, including the alder tree, a hardwood that could be valuable as a source of material for fuel, furniture, and construction. These plants also are useful for land reclamation.

Through genetic engineering, the bacterium could be made even more efficient at recycling nitrogen, or the microorganism could be transformed to colonize the root zones of other trees.

Microbiologists also identified two novel plant proteins and cloned the respective genes for application as biocontrol agents against bean weevils and several plant pathogenic fungi. The first, cloned from cultured tobacco cells, exhibits antifungal activity against a spectrum of pathogens. The second protein-related gene, cloned from a native Southwest American bean plant, gives a plant insecticidal properties. Goals for future research include genetic engineering research to develop new plants that express these valuable traits.

Computer Model Helps Guide Agricultural Policy

Policy changes concerning the federal budget deficit and agricultural technology have major long-term effects on farmers, consumers, taxpayers, and the economy, but these effects are often difficult for decision makers to measure.

A sophisticated computer simulation program is used at Auburn to help policy makers weigh the benefits and risks involved in decisions such as decreasing the national debt or banning pesticides.

The agricultural sector model, which runs on the Alabama Supercomputer, was used to determine that cutting the deficit by $30 billion a year over the next four years would increase real net farm income by approximately 5 percent annually. Nationally, that would mean an extra $1.4 billion a year in real livestock income and $200 million a year in real crop income.

Deficits damage agriculture in many ways. Higher interest rates and a stronger dollar, both products of high deficits, increase operating expenses and decrease exports. Falling farm cash receipts and rising operating expenses squeeze farm profits. Lower profits and higher interest rates will lower farm land values, adding more financial risk in the eyes of farm lenders.

In another study, the computer model indicated that farmers in the South could be dealt a lethal blow in some scenarios for banning common pesticides. The study looked at a variety of scenarios related to targeted bans of three pesticides — aldicarb, triazines, and acetanilides — in low-, medium- and high-risk zones.

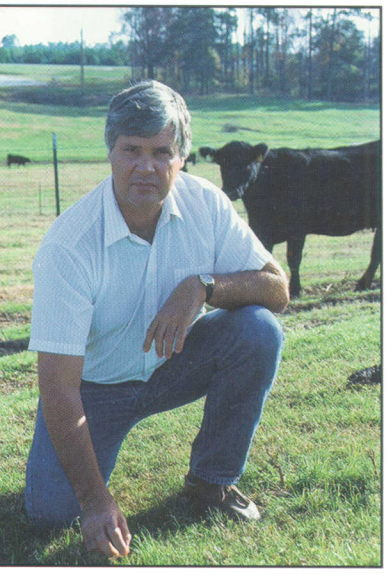
One scenario called for banning all three pesticides in all risk zones. Such a ban would cause annual crop income to drop nationally more than $2.1 billion, and livestock income would drop $350 million. The Southeast/Appalachian states would lose $298 million in crop income; the Delta states, $274 million.

C. Robert Taylor, ALFA/Alabama Farmers Federation Eminent Scholar in Agricultural and Public Policy, uses a sophisticated computer model he developed to gain insight into major policy decisions.

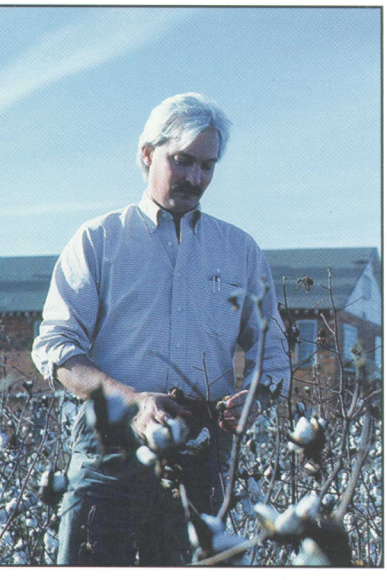
To make matters worse, the same scenario also would lower the annual Gross National Product by 0.2 percent, increase the budget deficit by 2.6 percent and raise food prices by 1 percent. U.S. consumers would have to pay $953 million more each year to maintain the current standard of living.

A national ban on all pesticides and inorganic fertilizers would increase crop income by $11.9 billion, but the GNP would drop 3.59 percent, the deficit would rise 18 percent, and consumers would have to pay an extra $30.5 billion to maintain the current standard of living.

Graeme Lockaby



David Bransby



Wesley Wood

Director's Research Awards

Three Auburn University faculty earned Alabama Agricultural Experiment Station Director's Research Awards in 1992. The awards, initiated in 1981 to recognize special career achievements by AAES scientists, include $10,000 unrestricted grants for use in the winners' research programs.

Recipients were Dr. B. Graeme Lockaby, professor of forestry; Dr. David I. Bransby, professor of agronomy and soils; and Dr. C. Wesley Wood, Jr., assistant professor of agronomy and soils.

Lockaby, a member of the AU School of Forestry faculty since 1986, has generated more than $2.2 million in extramural research funding and produced 18 refereed articles over the past five years.

As part of the Southern Global Climate Program, Lockaby's investigations have yielded information on the influence of climate on pine growth, effects of acid rain on pine, site preparation effects on deer habitat, and moisture-nutrient interactions in hardwoods. His results help to clarify how the productivity of individual trees and forest systems are limited.

In other research, Lockaby has shed new light on the impact of timber harvesting on wetland biogeochemistry.

Bransby has generated $922,400 in extramural grants and written 14 refereed articles since he joined the College of Agriculture in 1987.

In the area of forage/livestock production, Bransby's accomplishments include new methods to reduce losses from fescue toxicosis, methods of utilizing chicken litter, and information on optimal stocking rates and alternate forage species.

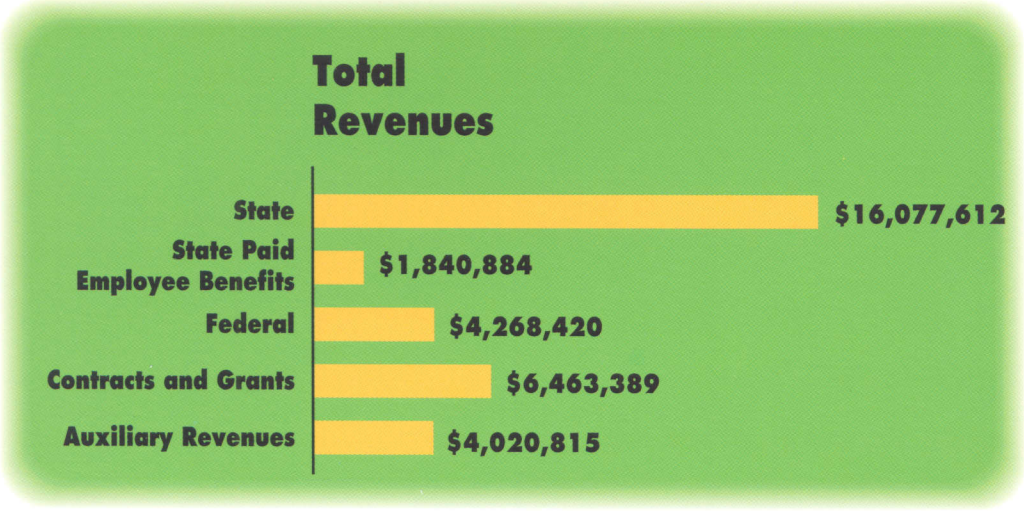
As part of the U.S. Department of Energy's biofuels program, Bransby was instrumental in identifying switchgrass as a promising energy crop for the Southeast. He found that the forage can be used as a highly economical source of biomass for ethanol production.

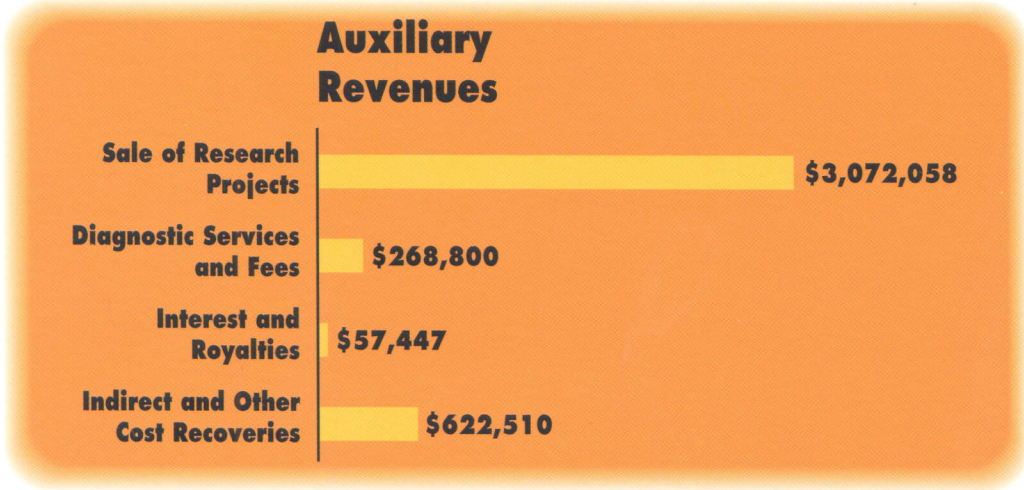
Since coming to Auburn in 1990, Wood has generated more than $1.2 million in extramural grants and authored 25 refereed articles.

His work emphasizes soil fertility and environmental chemistry. A major ongoing project by Wood involves the development of best management practices for using chicken litter in crop production while minimizing the risk of environmental degradation. His basic research in this area is aimed at determining nutrient and heavy metal release kinetics from manures.

Wood also is evaluating new and existing technologies for predicting crop nitrogen needs to provide Southeastern producers, crop consultants, and testing laboratories with the means to make site-specific nitrogen management decisions.

Financial Highlights





Alabama Agricultural Experiment Station Report of Revenues for the Fiscal Year Ending September 30, 1992