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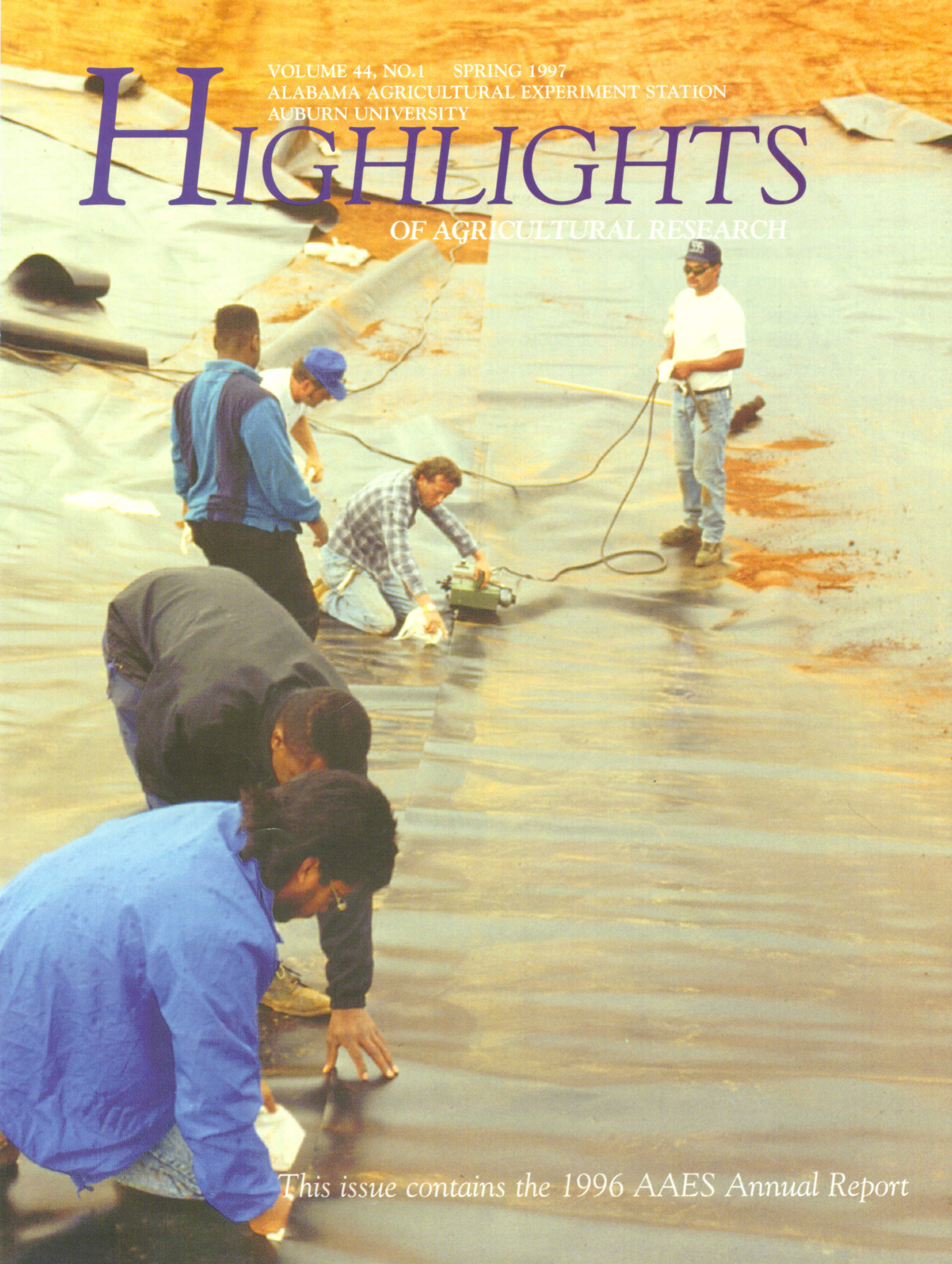
ALABAMA AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY

HIGHLIGHTS

OF AGRICULTURAL RESEARCH



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Alabama Agricultural Experiment Station Annual Report

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On The Cover: Workers install a high-density polyethylene liner in the 13-acre off-stream storage reservoir at the AAES Tennessee Valley Substation in Belle Mina. The facility allows researchers to develop an irrigation water supply that is reliable, environmentally sustainable, and does not compete with other water needs.

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A quarterly report of research published by the Alabama Agricultural Experiment Station, Auburn University.

The Alabama Agricultural Experiment Station (AAES) underwent significant change in 1996 as the AAES administration was merged with the College of Agriculture Dean's Office, and deans of the four other AAES-affiliated colleges and schools were named AAES associate directors. These administrative changes were made to reduce overhead costs and make the AAES more supportive of faculty and departmental units responsible for research needed for clientele and citizens of Alabama.

Never has AAES needed more help from the people it serves, and never have our clientele needed AAES more than at this time. We need a strong faculty, good facilities, and adequate operating budgets. While state budget reductions make these needs more acute, many entities are coming to our rescue. A coalition of agriculture, forestry, and veterinary medicine leaders are sponsoring legislation for a bond issue for new and renovated buildings at Auburn. This supplements gift dollars given by individuals and organizations for building programs. Other organizations support our research through grants and contracts at the highest level ever. Also, alumni and friends of the five AAES-affiliated colleges and schools are generously giving annual dollars for overall academic support.

We have the challenge now of (1) keeping the AAES organizations strong and effective in Alabama, (2) joining with the Alabama Cooperative Extension System in more cooperative research/extension efforts, especially at AAES locations across the state, and (3) supporting teaching efforts, especially at the graduate level where research expertise will be developed for future years.

This issue of Highlights is a unique product. It constitutes the 1996 AAES Annual Report. Making the Annual Report part of Highlights represents a significant cost savings for the AAES and puts the report before a much wider audience. Your comments on the report and its new format will be welcomed by this new director and his associates.

James E. Marion
Director, Alabama Agricultural Experiment Station

This juvenile red snapper is one of the fish raised in a revolutionary project that will help protect critical snapper habitats and could lead to methods for commercially producing the high-value fish.

Alabama Agricultural Experiment Station (AAES) research — conducted by faculty in Agriculture, Forestry, Human Sciences, Veterinary Medicine, and Sciences and Mathematics — constantly changes to meet the demands of the modern world. However, one factor never changes: AAES' commitment to the traditional land-grant mission of advancing the production of food and fiber, protecting our environment and natural resources, and improving the quality of life for all Alabamians. From basic to applied science, AAES research provides direct benefits to the industries that drive Alabama's economy and to all citizens of the state. Following are but a few examples of benefits provided by Experiment Station research in 1996.

Commercial Production of Red Snapper Made Possible by AAES Study

AAES and Alabama Marine Resources researchers in 1996 were the first to successfully raise red snappers in captivity. In all previous attempts to raise snappers, the fish never lived past 21 days. In the current project, red snappers have survived more than eight months and are well past the most critical times when death could occur.

Information gained in the study helped define the complete red snapper life cycle, which will allow resource managers to identify and preserve critical snapper habitats. Plus, the ability to grow red snapper in captivity could one day lead to the development of technology to raise the fish in ponds or special cages suspended in Mobile Bay or the Gulf of Mexico.

Aquaculture researchers closely simulated the red snapper's habitat in outdoor tanks at the Mariculture Center in Gulf Shores. Tanks were stocked with algae and small crustaceans to create a natural food chain. Gulf-caught red snappers were artificially spawned, and the resulting eggs were placed into the tanks to hatch. The young snappers are now spending the winter in indoor tanks.

Bollgard Increases Cotton Yields, but Reduces Production Costs

Aided by an intensive three-year AAES research effort, Alabama growers led the entire cotton belt in use of Monsanto's new genetically engineered cotton Bollgard, which is highly resistant to the devastating tobacco budworm. With the wide adoption of Bollgard, the state's cotton fields yielded an average of 750 pounds per acre — the second highest cotton lint yield in Alabama history. Some producers had yields approaching 1,500 pounds per acre.

Bollgard, a Deltapine cotton variety, expresses a *Bacillus thuringiensis* (*B.t.*) gene that produces proteins toxic to budworms. In studies at the AAES Prattville Experiment Field, entomologists found that Bollgard is 99% effective at controlling the budworm.

Growers in 1996 used the bioengineered cotton as part of an Auburn-developed Integrated Pest Management (IPM) program. Less than 20% of Alabama's 1996 cotton acreage was sprayed with insecticides. Taking into account the cost of using the *B.t.* cotton, use of the IPM program reduced the cost of cotton insect control about $46 million from the previous year.

Molecular biologists are refining a new genetic engineering technique that can be used to produce more effective transgenic crops without the negative side-effects of traditional bioengineered plants.

New Bioengineering Technique Could Result in Better *B.t.* Cotton

AAES molecular biologists in the Department of Botany and Microbiology have developed a new method for genetically transforming plants which could revolutionize efforts to develop bioengineered crops. Researchers are now using the technique to create a new type of *B.t.* cotton that would be even more effective than Bollgard.

Bollgard and other transgenic crops were transformed by placing a foreign gene in the single set of chromosomes that reside in the cell nucleus. This means that there is only one copy of the gene in each cell. The new AAES technique allows researchers to place foreign genes in a plant's chloroplasts, which means thousands of foreign gene copies would be expressed per cell.

Because of the low expression of the *B.t.* genes used in Bollgard, insects can develop resistance to the insecticidal proteins produced by the transgenic plant. Magnifying the expression by thousands will prevent insects from developing resistance. The new genetic engineering approach would also prevent "out-cross" problems that could otherwise lead to development of weeds resistant to pests and herbicides.

Bacteria Found to Improve Seedlings in Pine Nurseries

Without methyl bromide, an ozone-depleting fumigant scheduled to be banned, forest nurseries may not be able to produce the seedlings that are the foundation of the South's massive forest industry. In an effort to find an environmentally friendly alternative, AAES forestry researchers have identified several root-colonizing bacteria that allow a nursery to produce more and bigger seedlings.

Using bacteria shown by the AU Biological Control Institute to promote growth in agronomic crops, forestry researchers found that some strains helped seedlings emerge from the ground up to three days earlier than untreated seeds. These bacterial treatments also produced up to four extra seedlings per square foot, and all were of greater overall size and quality.

Although the bacterial treatments did help control seedling diseases, they were not as effective as methyl bromide. In an effort to provide pine nurseries more effective biologically based tools, researchers are screening bacteria from nurseries in hopes of discovering strains that specifically benefit pines.

Breakthroughs Point to Improved Protection Against Poultry Respiratory Disease

Mycoplasma gallisepticum, which causes a debilitating chronic respiratory disease (CRD) in poultry, is difficult to detect and control with currently available technology. Researchers in the AAES and AU College of Veterinary Medicine have identified two *M. gallisepticum* proteins that are vital mechanisms in the bacterium's ability to cause CRD and resist treatment. Further study of these proteins will aid in the development of effective diagnostic tools and immunization strategies against CRD.

One protein, an "adhesin," enables the bacteria to adhere to the host's respiratory tract tissues. The other protein, an "agglutinating antigen," makes the organism highly adaptable and resistant to the chicken's immune system, as well as current vaccines. Due to the presence of antigens on the bacterium's membrane surface, infected poultry or CRD carriers could be detected by reacting the blood serum from an affected chicken with the *M. gallisepticum* agglutinating (clumping) protein.

Researchers have identified the genes that encode for these two proteins. Current efforts are directed toward cloning the genes in *Escherichia coli* bacteria to produce large quantities of the proteins for use in efforts to develop a new diagnostic test and more effective treatments for CRD.

Scientists Seek to Prevent Costly Cellulitis Disease in Chickens

Avian cellulitis is an escalating problem for the U.S. poultry industry, costing more than $40 million annually. This disease, characterized by large infections under the skin, causes a bird to be condemned by USDA or severely trimmed at processing. Research by AAES poultry scientists has shed new light on the problem, including information that may one day provide a cure for this disease.

Researchers developed a method to realistically induce the disease in chickens. This experimental model is now used to evaluate potential antibiotics and vaccines in cooperation with veterinary pharmaceutical companies. Some of these treatments have shown promise for controlling cellulitis.

Poultry scientists are testing treatments for a disease that costs the poultry industry more than $40 million each year.

The experimental model is also used to study the disease-causing mechanisms of cellulitis. Using molecular techniques, researchers found that cellulitis infection is caused by a unique form of *E. Coli*. Identifying the characteristics of these bacteria and exploiting any weaknesses found will enable scientists to develop new preventative strategies.

Irradiation Extends Ground Beef Shelf Life Six Weeks

U.S. Department of Agriculture officials are

considering a petition to allow the irradiation of ground beef to improve its safety and shelf life. In preparation for this development, AAES food scientists are examining the effects of various levels of radiation on shelf life, bacterial content, sensory properties, and nutritional quality of ground beef.

Researchers are testing low doses of gamma radiation ranging from 1-7 kilograys (kGy); 1 kGy equals 100,000 rads. Preliminary results show that ground beef treated with 5-7 kGy was safe for consumption and of good quality up to six weeks in refrigeration. However, meat treated with 7 kGy developed an "off-odor" and strong aftertaste after six weeks of freezer storage. In the control treatment, untreated, refrigerated ground beef was inedible within a week.

Another interesting finding is that low doses of radiation (1-3 kGy) appear to merely injure *E. Coli* and bacteria associated with spoilage. Initial counts indicated no bacteria survived, regardless of dose level. But the bacteria recovered in low-dose treatments, whereas doses of 5-7 kGy killed all bacteria. Results from the vitamin content study are not yet analyzed.

Protein Recommendations for Dairy Cattle Too High

Milk production is on the increase in Alabama; the state imported 70% of its milk in 1980 but now must import only 40%. AAES research could spur further growth in Alabama's 270-farm dairy industry by substantially cutting feed costs for lactating cows. Dairy scientists demonstrated that excellent milk production and higher profits are possible by feeding less dietary protein, the most expensive component of a cow's diet.

Current recommendations are to feed cows an 18% protein diet through day 90 of the 305-day milk production cycle, 15.5% to day 180, then 13% for the rest of the lactation period. Based on recent research, dairy scientists suggest feeding cows 18% dietary protein through day 60, then decreasing it to 14% through day 250. This reduction saved approximately 57 cents per cow per day but resulted in about the same milk yield as the currently recommended diet.

Not overfeeding protein also decreases the environmental impact of dairy operations. Less protein in the diet means less nitrogen discharged from animal holding facilities.

Sesame Rotations Control Nematodes and Provide Alabama a New Cash Crop

Cotton, peanut, and soybean producers desperately need a weapon against nematodes to replace fumigants that have been or soon will be banned. AAES plant pathologists have found that planting sesame in rotation with these crops not only provides excellent nematode control, it has the potential to provide the state a major new cash crop.

Given a current market value of 25 cents per pound for sesame, researchers found that the break-even point for producing the crop is 400 pounds per acre. Experimental AAES plots in 1996 produced yields up to 1,500 pounds of sesame per acre. The world average sesame yield is 500-600 pounds.

Experiment Station sesame fields in 1996 yielded about three times more than the world average sesame yield.

Tests also showed that peanut yields were significantly enhanced in fields previously planted in sesame. Another accomplishment of the past year was the design of minor adaptations that will allow equipment commonly used in Alabama to harvest

sesame. Researchers continued to work out the details on how, when, and where to plant sesame in Alabama. In 1997, researchers will plant cotton and soybeans in fields that produced sesame in 1996.

Aggressive AAES Variety Trial Program Singles Out Top Vegetables

Vegetable growers face a daunting challenge in variety selection: there sometimes are hundreds of varieties of each crop, and the mix of varieties constantly changes. To help producers meet this challenge, AAES has emphasized comprehensive variety trials — including both commercially available and experimental varieties — since spring 1994.

Since performance is affected by many factors, at least three years of study are needed to scientifically identify Alabama's top-performing varieties. Based on results to date, researchers have identified the best-performing tomatoes, cucumbers, cantaloupes, watermelons, honeydew melons, summer squash, green bell peppers, colored bell peppers, and white, yellow, and bi-color sweet corn. Other crops in the program include southernpeas, zucchini, sweetpotatoes, okra, pumpkins, cabbage, broccoli, cauliflower, and lettuce.

Variety trials provide other benefits as well: they offer a format for demonstrating different growing systems, and they support studies related to nutritional quality, consumer preference, and post-harvest handling. In addition to benefitting Alabama growers, variety trial results are applicable from Texas to North Carolina.

AAES researchers found that selection of forage species affects erosion and nutrient runoff from grazed pastures.

Understanding the Environmental Impacts of Grazed Pastures

AAES agronomists and agricultural engineers are working to understand the importance of management variables on erosion, surface runoff, and nutrient loss from grazed pastures, especially those fertilized with poultry litter. Preliminary results indicate that the selection of forage species can play a role in minimizing these problems.

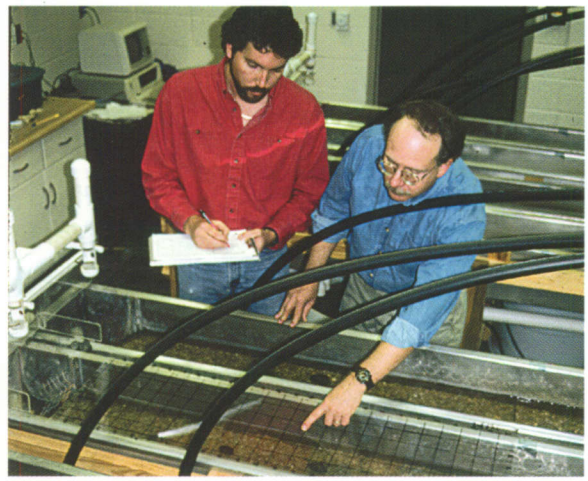
Regardless of grazing pressure, pastures of upright bunchgrasses such as switchgrass allowed more runoff and sediment in one year than more prostrate bunchgrasses such as tall fescue, or low-growing grasses such as common bermudagrass. However, tall fescue pastures yielded more nutrients in a year than switchgrass or bermudagrass, regardless of grazing pressure.

One goal of this project is to provide data for computer models used to develop conservation plans for protecting highly erodible land. Existing models were developed mainly with data from row crop operations. Therefore, databases for these models contain much less information on how erosion, runoff, and nutrient loss are affected by grazing land management variables such as forage species grown, grazing system, and cattle stocking density.

Shortfalls in softwood timber inventories could hurt Alabama's $6.4 billion wood products industry.

Alabama Agriculture Water Needs to Triple by 2050

Farm demand for water is expected to reach 1 billion gallons per day by 2050 in the 34-county area covered by the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint river basins in Alabama, Georgia, and Florida. This is according to the Agricultural Water Demand report, completed with the help of an AAES agricultural economist. As part of a comprehensive federal study of increasing water demands, the report is designed to guide water management strategies.



A unique indoor stream system is helping AAES zoologists protect endangered mussels in Alabama.

Agricultural water use in the basins was 400 million gallons a day (mgd) in 1992, of which Alabama used 21%. Demand is expected to reach 550 mgd by 2000. Alabama farmers are predicted to need 120 mgd by 2000 and 260 mgd by 2050.

Only 6% of Alabama crop, orchard, nursery, and turf producers in the basin areas irrigated in 1992; irrigation needs are expected to double by 2000. Short-term water restrictions of 60% in 2000 could cause gross losses of more than $114 million for corn, peanut, and soybean growers in the basin areas. A complete cutoff of irrigation would cost more than $203 million gross.

Zoologists Develop Unique Indoor Lab to Study Freshwater Mussels

Alabama boasts the nation's greatest diversity of freshwater mussels, which are economically important as pearl-seeding material for the Japanese pearl industry and ecologically important as a part of the aquatic food chain. Mussels once were abundant in Alabama waterways, but now about half of all mussel species are endangered, threatened, or of special concern.

Mussels are known to be sensitive to water contamination from heavy metals, chemical runoff, and nutrient enrichment. However, it is not known whether the freshwater shellfish are vulnerable to water clouded by excess sediments. It is possible that mussels, which feed by filtering water through their bodies, may not be able to get enough food or may stop feeding altogether in very cloudy water.

To address this issue, AAES zoologists have created a unique lab to assess the short-term environmental stress of suspended sediments on mussels. Researchers can observe mussel movement, shell growth, body condition, and feeding behavior in eight recirculating tanks treated with varying amounts of powdered clay to simulate sediment in streams.

Alabama Timber Inventories Are Declining

AAES forestry research shows that Alabama's timber inventories are being harvested faster than they are being replenished through growth, and further inventory declines are expected. Declining inventories could seriously impact the state's $6.4 billion wood products industry.

Federal forest inventory reports are released every eight to 10 years, but in the intervening years, forest managers face much indecision concerning timber availability. AAES researchers developed a computer model to update the 1990 inventory report using annual severance tax returns, which are paid on the final products produced from timber in Alabama. With an annual harvest estimate based on these data, researchers projected timber inventories for the next 20 years.

Softwood inventories dropped 5% from 1990-95, and another 10% drop is expected by 2000. In 2005, timber inventories could be 25% below the 1990 level. Even with a federally forecasted 91% increase in pine plantations by 2020, there will still be a shortfall in softwood inventories. Researchers are now using the model to examine ways the forest industry can mitigate this deficit, such as increasing the use of oriented strand board in structural panels and improving the growth rate of forests.

Auburn researchers use a multidisciplinary thermal laboratory to examine heat stress and other physiological responses to working in protective clothing, such as the garments worn by forestry wood workers.

Off-Stream Storage Project Goes into Full Swing in 1996

Alabama ranks 10th in U.S. cotton production, with approximately 400,000 acres of the crop. Cotton yields would be drastically increased by irrigation, but that is not an option available to all producers. A five-year, $1.35-million project was launched in 1996 to provide producers of cotton and other crops an otherwise unavailable water supply that is reliable, environmentally sustainable, and does not compete with other water needs.

Located at the AAES Tennessee Valley Substation in Belle Mina, this project allows agricultural engineers to test the feasibility of pumping water from a nearby stream during the rainy winter months and using it to irrigate crops in the dry summer months. A model 13-acre "off-stream storage" pond was completed and is being used as a source of water for 144 research plots irrigated by sprinklers or drip irrigation. These plots are being used to determine minimum off-stream storage requirements for each acre of cotton. In addition, the facility was used in 1996 to study irrigation management and evaluate a new variety of genetically engineered cotton.

Textile Research Results in Improved Protective Garments

AAES consumer affairs researchers, working through the National Textile Center, have an active program of designing and testing protective garments for timber harvesters, military personnel, fire fighters, and other emergency workers.

In one study, researchers found that coating cotton fabric with titanium dioxide particles creates a barrier that absorbs organic materials, such as chloroform, phosgene, and other hazardous chemical vapors. When the coated fabric is exposed to ultraviolet light, these harmful chemicals are broken down into salt, water, and carbon dioxide.

Another study resulted in the development of a method for testing friction between fabrics in different layers of protective garments. Too much friction between fabrics impedes movement and makes the garment uncomfortable. Finding the right combination of fabric finishes will aid in the design of more effective barrier garments. Using the new technique, researchers tested interfabric friction in garments that include fabrics treated with various flame retardants (FR). Contrary to commonly held beliefs, results showed that not all FR finishes increase friction. In fact, some finishes made fabrics less stiff and easier to slide against other fabrics in multi-layer garments.

ALABAMA AGRICULTURAL EXPERIMENT STATION PROJECTS APPROVED AS OF OCTOBER 1, 1996

Department of Agricultural Economics and Rural Sociology

Marketing Strategies for Selected National Forests in Alabama
H. Clonts

Economics of Commodity Advertising
H. Kinnucan

Economic Issues Affecting the U.S. Fruit and Vegetable System
J. Adrian

An Evaluation of International Markets for Southern Commodities
C. Jolly, P. Duffy, H. Kinnucan & N.R. Martin

Decision-Making under Uncertainty and the Economics of Risk in Alabama Agriculture
R. Nelson & J. Novak

Farm-Level Economics of the Alabama Crop and Livestock Sector
P. Duffy, L. Johnson & N.R Martin, Jr.

Department of Agricultural Engineering

Engineering Principles for Conservation Cropping Systems
C. E. Johnson & L.J. Kutz

Simulation and Automation to Improve Quality, Productivity and Performance in Agriculture and Forestry
L. Kutz

Department of Agronomy and Soils

Field Crop Variety Testing
D. Bransby

Plant Genetic Resources Conservation and Utilization
J. Mosjidis

Classifying Soils for Solute Transport as Affected by Soil Properties and Landscape Position
J. Dane, J. Adams & B. Hajek

Sustainable Whole Farm Grain/Silage Production Systems for the Southeast (P.L. 89-106 Special Grant - Sustainable Agriculture)
W. Reeves

Intercropping Small Grains and Lupin for Sustainable Agriculture (P.L. 89-106 Special Grant - Sustainable Agriculture)
E. van Santen

Sustainable Weed Management in Row Crops
R.H. Walker

Weed Management and Herbicide Development for Peanuts
G. Wehtje

Nutrient Management in Sustainable Agricultural Systems using Continuous, Long-Term Plots
C.C. Mitchell, Jr.

Microbial Interactions in Agricultural and Forestry Ecosystems
J. Entry

Establishment and Maintenance of Turf
E. Guertal

Improving Efficiency of Forage and Forage-Based Livestock Production in Alabama
D.I. Bransby

Ecology of Perennial Forages and Sustainable Cropland-Forage Systems in Alabama
M. Miller

Soil Fertility for Sustainable Alabama Vegetable Production
E. Guertal

Integrated Sustainable Production Practices for Cotton (*Gossypium hirsutum*)
C.D. Monks

Broiler Litter Management in Major Land Resource Areas of the Southeast: N Loss and Water Quality (P.L. 89-106 Special Grant - Water Quality)
C.W. Wood & E. Guertal

Effect of Tillage and Soil Fertility Practices on Peanut Production
J. Adams & D. Hartzog

Chemistry and Bioavailability of Waste Constituents in Soils
E. Guertal

Integrated Weed Management for Sustainable Conservation Tillage Cropping Systems
M Patterson

Phenology, Population Dynamics, and Interference: A Basis for Understanding Weed Biology and Ecology
R. H. Walker

Diversity and Interactions of Beneficial Bacteria and Fungi in the Rhizosphere
J. Entry

Utilizing Potassium Buffering Capacity to Predict Cotton Yield Response to Potassium Fertilizer
G. Mullins

Department of Animal and Dairy Sciences

Improvement of Reproductive Performance in Beef Females
C. Rahe & S. Schmidt

Dietary Protein Adequacy in Lactating Dairy Cows
K. Cummins and G. Davenport

Lean Meat Production and Utilization
D. Huffman, W. Mikel & R. Smith

Dairy Herd Management Strategies for Improved Decision-Making and Profitability
K. A. Cummins

Alleviation of Environmental Constraints to Beef Cattle Production in the Southeastern United States
S. P. Schmidt

Nutritional Systems for Swine to Increase Reproductive Efficiency
L. Chiba

Selection for Lean Growth in an Open-Nucleus Swine Herd
D. Kuhlers

Nutritional Regulation of Insulin-like Growth Factor-I in Ruminants to Enhance Lean Meat Production
G. Davenport

Use of Low-Cost Supplements for Beef Cattle Consuming Low-Quality Forages
D. Rankins

Evaluation of Unconventional Forages (Silages) and Alternate Feeds for Dairy Cattle
B. Moss

Cellular and Molecular Organizational Events Affecting Porcine Uterine Capacity (P.L. 89-106 Competitive Grant)
F. F. Bartol

Molecular Mechanisms Regulating Skeletal Muscle Growth and Differentiation
D. Mulvaney

Developmental Determinants of Ungulate Uterine Capacity
F. Bartol, D. Coleman & J. Floyd

Plant Tissue Chemistry Response to Ozone Stress with Implications to Ruminant Herbivory
R.B. Muntifering

Relationships among Early Handling, Learning Ability and Reactivity of Foals
C.A. McCall

Department of Entomology

Biology and Management of the White-Fringed Beetle and Other Vegetable Insects
G. Zehnder

Biting Midges as Vectors of Animal Diseases in Alabama
G. Mullen

Biology and Management of Insects of Trees of Alabama
L.L. Hyche

Exploratory Research in Entomology
W. Brewer

A National Agricultural Program to Clear Pest Control Agents for Minor Uses
G. Zehnder

Systematics of Weevils (*Curculionidae*) of the Tribe Anthonomini
W. Clark

Factors Governing the Relative Importance of Bees as Pollinators
J. Cane

Systematics of Scale Insects (*Homoptera: Coccoidea*)
M. Williams

Evaluation of Pest Management Systems in Peanuts
J.R. Weeks

Salivary Gland Physiology of the Cattle Ectoparasite, *Haemotobia Irritans*
E.W. Cupp & M.S. Cupp

Development and Integration of Entomopathogens into Pest Management Systems
W. Moar

Biological Control of Selected Arthropod Pests and Weeds
M. Gaylor

Management of Tarnished Plant Bug and Secondary Pests of Cotton in the Absence of Boll Weevil
M. Gaylor

Improved Systems of Management for Pecan Insect and Mite Pests
J. R. McVay

Biology and Control of Urban Arthropod Pests in Alabama
A. Appel

Impact and Management of Green June Beetle and Other Scarabeid Grubs in Alabama Pastures
K. Flanders

Isolation and Characterization of Anticoagulant Activity in Horn Fly Saliva (P.L. 89-106 Competitive Grant)
E.W. Cupp & M.S. Cupp

Integrated Pest Management of Termites
F. Oi

Department of Fisheries and Allied Aquacultures

Environmental Pathology of Fish
J. Grizzle

Enhancement of Oyster Production in Coastal Waters of Alabama through Aquaculture
D. B. Rouse, Y. J. Brady, R. K. Wallace & W. Hosking

Vaccination, Control and Causes of Bacterial Diseases of Catfish and Other Warmwater Fish
J.A. Plumb

Advancement of Hatchery Technology for Catfish and Other Commercially Important Fish Species
R. Phelps

Coastal Alabama Seafood Harvest (CASH) Project (P.L. 95-113 Cooperative Agreement)
D. Rouse

Model Annual Abundance of Commercial Shrimp Species and Quantify Factors that Influence Distribution and Abundance
R.K. Wallace & W. Hosking

Refinement of Channel Catfish Feeding Practices as a Management Tool
T. Popma

Bioassessment of Alabama Streams and Reservoirs
D. Bayne & E. Webber

Management of Aquaculture Ponds to Reduce Pollution Loads
C. Boyd

Department of Horticulture

Develop and Distribute Deciduous Fruit Tree Clones Free of Viruses and Virus-Like Agents
J. Norton

Urban Tree Evaluation and Environmental Factors Affecting Urban Landscape Plant Use
C. Gilliam, G. Keever, H. Ponder & D. Williams

Biochemical Basis of Low Temperature Acclimation in Ripening Tomato (*Lycopersicon esculentum*)
F. Woods

Cultural Practices and Cultivar Evaluations for Pecans
W. Goff

Evaluation of Peach and Apple Management Practices
W. Dozier, Jr.

Growth Regulation of Herbaceous Woody Ornamental Plants
G. Keever

Development of Sustainable Double-Crop Vegetable Production Systems for Alabama
J. Kemble

Molecular Markers for the Genetic Analyses of Plant-Microbe Interactions
F. Dane

Implementation of Tomato IPM Practices (P.L. 89-106 Special Grant - IPM)
E. Bauske

Department of Plant Pathology

Managing Plant-Parasitic Nematodes in Sustainable Agriculture with Emphasis on Crop Resistance
R. Rodriguez-Kabana

A Biological Control System for Root and Foliar Pests of Vegetables (P.L. 89-106 Competitive Grant)
J.W. Kloepper, P.A. Backman & G.W. Zehnder

Plant-Colonizing Bacteria for Use in Plant Disease Control or Plant Growth Promotion
J.W. Kloepper

Integrated Biological Control of Cotton Diseases and Nematodes (P.L. 89-106 Competitive Grant)
R. Rodriguez-Kabana, E.M. Bauske & J. Kloepper

Organic Amendments to Soil for the Management of Phytonematodes: Mode of Action and Microbial Ecology
R. Rodriguez-Kabana

Epidemiology of Plant Diseases in Crop and Urban Landscape Ecosystems
K. Bowen

Integrated Approaches for Control of Bacterial Diseases of Tomato and Pepper (P.L. 89-106 Special Grant - IPM)
M. Wilson

Significance of Resource Limitation to Biocontrol of Epiphytic Phytopathogenic Bacteria (P.L. 89-106 Competitive Grant)
M. Wilson

Ecological Approaches to the Biocontrol of Foliar and Floral Bacterial Pathogens and Pests
M. Wilson

Biological Control and Management of Soilborne Plant Pathogens for Sustainable Crop Production
D. Collins

Plant Viral Disease: Plant-Virus Interactions and Development of Management Strategies
J. Murphy

Agricultural Systems Management with Current Technologists: On-Farm Application of Doppler Radar
K. Bowen, E Bauske, A. Hagan, P. Backman

Department of Poultry Science

Environmental Factors Influencing Broiler Growth and Meat Yield
J. Renden and E. Moran

Maximizing Profits In Commercial Leghorns while Minimizing Prolapse, Nitrogen and Phosphorus Pollution
D. Roland

Immunogenetics and Cellular Immunology of Resistance to Marek's Disease
S. Ewald

Genetic Bases for Resistance and Immunity to Avian Diseases
S. Ewald

Improved Diagnosis of Avian Reoviruses Using Molecular Biologic Techniques
J. Giambrone

Genetic Relationships of Growth and Reproduction in Diverse Poultry Populations
G. McDaniel

Development of New Processes and Technologies for the Processing of Poultry
E.T. Moran, S.F. Bilgili & D.E. Conner

The Interaction of Enteric Pathogenic Organisms and Their Effect on Poultry Health
R.A. Norton & S.J. Ewald

School of Forestry

The National Atmospheric Deposition Program: A Long-Term Monitoring Program in Support of Research on the Effects of Atmospheric Chemical Deposition
A. Chappelka

Effects of Changes in Chemical and Physical Climate on Forestry Productivity in the Southern United States
A. Chappelka

Incorporating Physiological Processes into Growth and Yield Models of Southern Pine
G. Somers and R. Meldahl

The Chemistry of Lignin Complexes
T. Elder

The Functions, Values and Uses of Forested Wetlands:How to Use the Resource in a Sustainable Manner
K. Flynn

Environmental Impact and Serviceability of Forest Roads
R. Tufts

Artificial Regeneration of Southern Pine
D. Gjerstad

Reducing the Need for Herbaceous Weed Control by Improving Southern Pine Seedling Quality
D. South

Modeling Natural Forest Stands in the South
R. Meldahl

Forwarder Systems for Timber Harvesting
B. Lanford

Effect of Stand Density on Grade Yield and Flexural Properties of Plantation-Grown Southern Pine Lumber
E. Biblis

Economic Analysis of Forest Policy and Timberland Investment
D. Zhang

Time-Dependent Structural Behavior of Oriented Strandboards
R. Tang

Physiological Mechanisms Controlling Tree Response to Environmental Stress
L. Samuelson

Growth, Yield and Economics of Vegetation Management in Southern Pine Plantations
G. Glover

Forestry and Social Change
J. Bliss

Characterization and Mechanisms of Plant Response to Ozone in the Northeastern U.S.
A. Chappelka

Assessing the Environmental Impact of Artificial Regeneration Systems in Southern Forestry
K. McNabb

Forest Resources Management in the Southern U.S.
M.R. DuBois

Development and Implementation of Disease Control for the Production of Forest Trees
S. Eneback

Timber Supply Modeling and Policy Analysis
L.D. Teeter

Increasing Value-Added Contribution of Wood Processing: Modelling and Analysis of Integrated Operations
H. Carino

Policies and Institutions in the Southern Forest Economy
W. Flick

Duration of Load Behavior Laminated Veneer Lumber with Glue Joints (P.L. 89-106 Competitive Grant)
R. Tang

Implications of Regulations and Property Rights Laws for Forest Land Use and Management (P.L. 89-106 Competitive Grant)
D. Zhang & W. Flick

Department of Consumer Affairs

Technology and Competitiveness: An Assessment of Alabama Small Apparel and Textile Producers in Rural Communities and Development of Related Computer Technology
L. Shanley

Identifying Export Market Opportunities for Alabama Apparel Producers
S. Forsythe

National Textile Center: Computer-Integrated Forecasting for Demand-Activated Product Development, Production and Merchandising
E. Brannon and L. Anderson

National Textile Center: Gas, Liquid, Aerosol Fabric Barrier Systems
L. Shanley and I. Hardin

National Textile Center: Marketing U. S. Apparel Products in Mexico
S. Forsythe

National Textile Center: Computer-Integrated Prototype to Enhance Demand-Activated Manufacturing for the Domestic Apparel Industry
L. Anderson

National Textile Center: MFA Phaseout - Implications for the U. S. Fibers/Textiles/Fabricated Products Complex
M. Barry and C. Warfield

Evaluation of Lifestyle Imagery by Producers and Consumers in the Apparel and Textile Pipeline
M. Solomon

Mass Customization: Identifying Process and Management Strategies for Alabama's Integrated Textile Complex
L. Anderson

Department of Family and Child Development

Social Support Networks and Well-Being in Rural and Non-Rural Families in Alabama
D. Sollie

Predicting Marital Dissolution: A Four-Year Prospective Longitudinal Study of Engaged Couples
L. Lamke

The Work-Family Interface: Perspectives from Employers and Employees in Small and Mid-Sized Businesses
J. Pittman

Parental Influences on Children's Well-Being:Multiple Pathways to Social Competence
J. Mize & G. Pettit

Facilitating Access to Health Care for Low-Income Families in Alabama: The Role of Head Start
B. Vaughn

Department of Nutrition and Food Science

The Effects of Physical Activity and Carbohydrate Intake on Thiamin and Ascorbic Acid Needs in Man and Animals
R. Keith

Development of Monoclonal Antibody-Based Immunoassays for Detection of Species Adulterants in Cooked Meats
Y-H. Peggy Hsieh

Processing Factors Affecting Food Quality and Nutrient Composition
J. Olds-Weese

Dietary Fat and Infant Development
M. Craig-Schmidt

Chemical Reactions in Foods as Impacted by the Properties of Water
L. Bell

Nutrient Analysis and Interactions
S. Gropper

Food Chemical Stability in Solids: Impact of Water and the State of the System (P.L. 89-106 Competitive Grant)
L. Bell

Department of Botany and Microbiology

Characterization of Mitochondrial DNA Replication in *Brassica campestris* and *B. hirta*
B. Nielsen

Biochemistry and Biotechnology of Fungal Lipids
J. Weete

Metal Uptake by *Streptanthus polygaloides* and *Arabidopsis thaliana*
R. Boyd

DNA Analyses for Rapid Detection, Strain Differentiation, and Vaccine Development for the Fish Pathogen, *Edwardsiella ictaluri*
J. Barbaree

The Bacterial Transposable DNA IS2: How Proteins Mediate and Modulate Both Excision and Transposition
R. Musso

Characterization, Cloning and Functional Analysis of Maize Sorbitol Dehydrogenase
R. Locy

Genetic Engineering of Chloroplast Genomes for Stress Tolerance and Molecular Farming in Plants
H. Daniell

Pit Membrane Structure and Development in Hardwoods
R. Dute

Production of High-Value Biodegradable Polymers in Tobacco (P.L. 89-106 Competitive Grant)
H. Daniell

Detailed Characterization of Tobacco Chloroplast DNA Replication Initiation Sites (P.L. 89-106 Competitive Grant)
B. Nielsen

Molecular and Cellular Aspects of Heat Stress on Yield and Composition of Proteins and Fatty Acids in Legume Plants
J.H. Cherry & N.K. Singh

Molecular Basis of Black Rot
J. Shaw

Hormonal Control of Gene Expression in Abscission of Cotton
C.M. Peterson

Department of Zoology and Wildlife Science

Antisense Oligonucleotides as Specific Inhibitors of Protein Kinase C Isoforms
M. W. Wooten

Development of Molecular-Based Indicators of Anthropogenic Stress in Aquatic Ecosystems
M. C. Wooten

Basic Aspects of Neurodevelopment in *Berghia verrucicornis*
S. Kempf

Evaluation of Benthic Invertebrates, Water Quality and Watershed Conditions in Southeastern Streams
J. Feminella

Evaluation of Female Mate Choice and Carotenoid-Based Plumage Ornamentation
G. Hill

Southern Reservoirs as Habitat for Migratory and Wintering Waterfowl
G. Hepp

Population Dynamics and Habitat Use by Alabama Beach Mice (*Peromyscus polionotus* ammobates)
M.C. Wooten & N.R. Holler

The Biochemical Analysis of Fish Sperm Dynein and Associated Polypeptides
A. Moss

Diagnosis and *In Vitro* Development of *T. gondii*, and Inactivation of Protozoa in Drinking Water
C. Sundermann

Yolk Processing during Insect Development
J. Bradley

Carbonic Anhydrase and the Evolution of Environmental Signal Transduction
R.P. Henry

Ecology of Bats (*Mammalia: Chiroptera*) in Alabama
T. Best

Environmental Endocrine Disruptors' Effect on Reproduction: Hormonal and Cellular Correlates
M. T. Mendonca

Public Perceptions about Wildlife Management in Alabama
J.B. Armstrong

Department of Animal Health Research

Cloning of Mycoplasma gallisepticum-specific Agglutinating Antigen Gene(s)
V. Panangala

Ratite Disease Research
P. Smith

Epidemiological Considerations of Systems for Production and Transfer of *In Vitro*-Derived Bovine Embryos
D. Stringfellow

Nutrition and Disease Factors as Negative Regulators of the Growth Hormone Axis in Ruminants
J. Sartin

Species-Specific Detection of Cryptosporidium in Water using Molecular Probes (P.L. 89-106 Competitve Grant)
C. Dykstra

Joint (Interdepartmental) and Miscellaneous

Administrative Planning and Direction of Research
J. E. Marion

Regional Research Coordination, Southern Region - Administration
J. E. Marion

Skeletal Problems in Poultry
G. McDaniel and S. Kincaid

Engineering-Economic Analysis of Irrigation and On-Farm Water Management in Alabama
E. Rochester & L. Hatch

Technical and Economical Efficiencies of Producing, Marketing and Managing Landscape Plants
J. Adrian, J. Eakes & K. Tilt

Water Management (P.L. 89-106 Special Grant)
J. Marion

Interior Environment and Energy Use in Poultry and Livestock Facilities
J. Koon, R. Brewer, C. Flood & B. Moss

Water Management, Alabama (P.L. 89-106 Special Grant)
J. Marion

Development of an IPM System for Management of German Cockroaches (P.L. 89-106 Special Grant - IPM)
A. Appel & J. Koon (ENT & AN)

A Biologically-Based IPM Program for Control of Cucumber Mosaic Virus on Tomato (P.L. 89-106 Special Grant - IPM)
G. Zehnder, J. Murphy, E. Sikora & J. Kloepper

Use of Propionate and Organic Acids to Inhibit the Growth of Foodborne Pathogens in *vitro* and in Ground Poultry and Beef Products
A. Hinton, Jr. & D. Conner

Development and Evaluation of Control Strategies for Diseases of Landscape Plants
K. Tilt & A. Hagan

Surface and Atomic Force Characterization of Wood Cellulose Surfaces (P.L. 89-106 Competitive Grant)
R. D. Newman

Development of Cage and In-Pond Raceway Systems to Culture Fish in Watershed Ponds
M. Masser, L. Lovshin, R. Goodman, J.. Crews & K. Yoo

Evaluation and Development of Plant Pathogens for Biological Control of Weeds
P.. Backman, F. Dane & J. Shaw

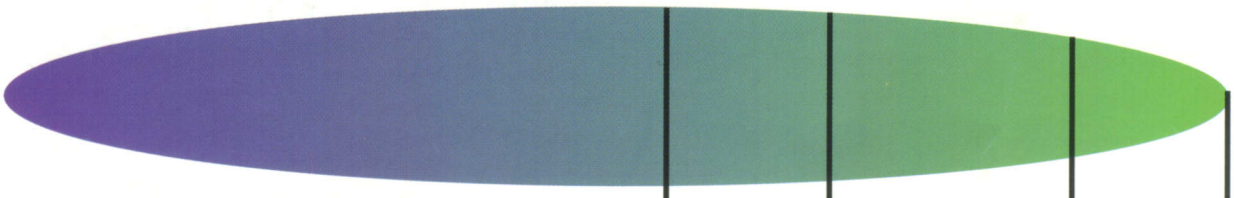
Weed Control in Nursery and Landscape Crops
C. Gilliam & G. Wehtje

Control of Cucumber Beetle and Bacterial Wilt of Cucurbits with Beneficial Bacteria (P.L. 89-106 Special Grant - IPM)
G. Zehnder & J. Kloepper

Raw Soybeans and Whole Kernel Corn as Diet Supplements for Captive White-Tailed Deer
M. Causey & R. Muntifering

1996 FINANCIAL REPORT

TOTAL REVENUES
$37,911,626



State		$20,507,794
Federal		$4,446,514
Contracts and Grants		$9,363,822
	Federal $4,662,897	
	Private $3,713,592	
	State $987,333	
Auxiliary		$3,593,496
	Sale of Research Products $2,351,130	
	Indirect Cost Recoveries $969,657	
	Diagnostic Services $233,841	
	Interest and Royalties $38,868	

ALABAMA AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY
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James E. Marion, Director
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