



1987
Annual Report

Alabama Agricultural Experiment Station
Auburn University



COVER STORY. Better utilization of natural resources is an ongoing goal of researchers in the Alabama Agricultural Experiment Station. Here panels made from sweetgum, red oak, and white oak, species often considered 'waste trees' in pine plantings, are being tested for long-term performance. Wood from this type construction is commonly used for decking, flooring, and other structural panels in residential housing.

ADMINISTRATIVE OFFICERS

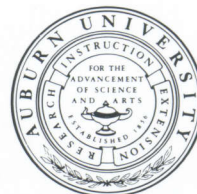
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Foreword

Service and teamwork are twin themes of the 1987 Annual Report of the Alabama Agricultural Experiment Station. Findings from selected projects illustrate the type of scientific information being generated in a research program that is dedicated to improving the efficiency of Alabama's forestry and agricultural industries and to enhancing quality of life of all Alabamians. The teamwork theme, more of a between-the-lines glimpse, reveals how researchers in different disciplines work together to solve the diverse problems facing the State's many agricultural and forestry enterprises.

In the past when maximizing production was a logical approach to boosting the agricultural economy, individual subject matter research made significant improvements. Today's problems are too complicated for such a simplistic approach, and our research programs must emphasize systems of farm or forestry production. This

calls for teams of scientists working together. For example, a particular problem may require a soil scientist, plant breeder, genetic engineer, weed scientist, plant physiologist, agricultural engineer, plant pathologist, entomologist, biochemist, statistician, silviculturist, animal scientist, and economist. Maximum production is no longer the ultimate goal. The only real measure of success is how much money is left after paying all costs, so our research now and in the future will focus on maximizing net returns.

A new concern that must be addressed by our research program relates to how changes in one practice will affect other aspects of the enterprise or how changes in one commodity will affect other commodities or the total agricultural economy. Federal, state, and local policies and environmental protection also must be considered in developing production and marketing strategies.

An integral component of the agricultural team must be the final user of our products. We must consider the consumer's preferences in research to develop efficient farming systems. There can be no future in producing a product that is unacceptable to the consumer or one that is too costly, and we certainly do not wish to produce something that is detrimental to human health. Family and child development specialists must continually assess changes in family life styles. Nutritionists must investigate eating patterns and ascertain how to furnish the required nutrients for proper growth, development, and health of the consumer. This type research must be integrated with production research so that solutions to problems will be beneficial to all.

Since funds for research are limited, resources must be channeled through a team effort to solve the most important problems facing Alabamians. It was through a team effort that the United States was able to put a man on the moon, to develop and implement organ transplants, to provide instant communication throughout the world, and to increase the life span of all people. Such a team effort offers the best chance for success in agriculture.

The Alabama Agricultural Experiment Station is dedicated to a team effort. Your assistance in that effort is needed.

Lowell T. Frobish
Director



Alabama Agricultural Experiment Station Director Dr. Lowell Frobish.

Current and Future Generations Benefit from Agricultural Research

AGRICULTURAL research in 1987 moved farther into the new era of biotechnology and genetic engineering, building a base of knowledge to keep us on the cutting edge of technology for generations to come. At the same time, researchers continued to provide knowledge that can be applied to current problems.

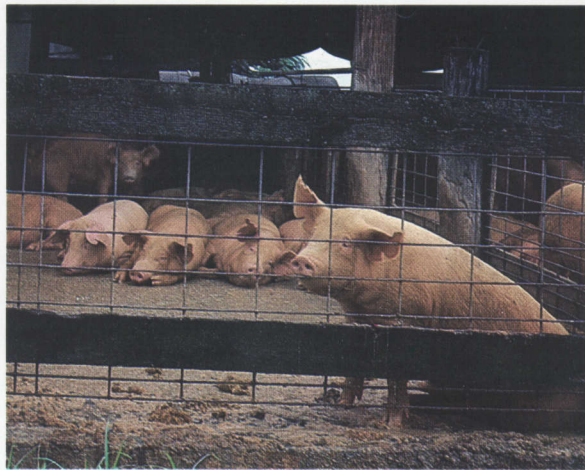
Drought, as it did in 1986, hampered farmers and researchers throughout much of the State. The State's cotton crop, thought at one time during the season to be among the best on record, suffered dramatically from the drought. Researchers using the Comax-Gossym computer program utilized the unusually dry weather to add new parameters to the program that promises to be a valuable cotton management tool in the future. Other crops, like peanuts and pecans, suffered similarly from the drought, but researchers continued to gain valuable insights into production and pest management techniques that will prove valuable in future seasons of adverse growing conditions.

Animal research is undergoing revolutionary change as Americans further develop health and time conscious diets. Researchers working with cattle, swine, poultry, and fish are seeking ways to develop higher protein and lower calorie and cholesterol products. Poultry researchers, for example, are monitoring the movement of fat deposits in chickens and turkeys as they age, hoping to develop nutritional and genetic means of further reducing the level of fat in poultry products. Researchers in fisheries and aquaculture are playing a key role in the "blue revolution" aimed at providing fish and shellfish from fresh and saltwater ponds to augment depleted harvests from the sea.

Value added products, though stressed in all areas of research, are drawing special interest from forestry researchers. Wood products from sweetgum, poplar, and other species that are undesirable in pine plantings are being used in flakeboards that are ideal for exterior sidings, concrete forms, and other utility uses. High value parallel laminated veneer lumber made from these trees is being used in high stressed structural buildings and furniture. Use of an Auburn-developed computer aided design of wood products operations is already making production of these new products more efficient.



Low prices to growers for traditional crops, such as grain sorghum, have forced farmers to seek alternative crops and enterprises.



Reducing livestock diseases, such as coccidiosis in pigs, will help improve profits for State producers.



Bringing growers and researchers together at field days is one way of spreading research generated technology.

Though food and fiber research has traditionally spearheaded the mission of the Experiment Station, other work is also having a profound impact on human health and nutrition and on our environment. Results from biotechnology work done on animals is providing valuable information to medical scientists in their quest to conquer AIDS. Vitamin E studies have provided vital information on the relationship between selenium and vision problems in premature babies, and has dispelled many health claims of the popular vitamin. Our environment has benefited from work in all five of the schools and colleges—Agriculture, Forestry, Human Sciences, Science and Mathematics, and Veterinary Medicine—that currently conduct research under the auspices of the Experiment Station.

Research has demonstrated the need for alternative income sources for farmers. Horticulture researchers are testing kiwi fruit, feijoa, passion fruit, pepino dulce, and other high income exotic crops to determine their suitability to Alabama soils and climate. More traditional alternative crops, such as plums, strawberries, blueberries, blackberries, broccoli, asparagus, super sweet corn, and a number of other vegetable crops, are being analyzed for production and economic potential in both commercial and pick-your-own operations. Application of growth regulators and use of artificial light to extend growing periods are being studied as a means to more efficiently grow

woody ornamental crops, and progress is being made to adapt these plants for indoor use in homes, office buildings, shopping malls, and other public buildings. Wildlife researchers are developing quail, duck, deer, dove, and turkey feeding and reproduction guidelines to help landowners use fallow farm land for fee hunting.

Information gained by Experiment Station scientists belongs to all, and last year Auburn researchers published 464 research reports in publications read by scientists throughout the world. A total of 32 bulletins and other publications was released by the Experiment Station and nearly 500 popular articles were published in newspapers and magazines. In addition, Alabamians got a first hand look at Experiment Station research during field days and other meetings at outlying research units throughout the State. To better understand the research needs of Alabama agriculture, Director Frobish held a series of meetings with key agribusiness leaders at each of the Experiment Station's 14 outlying research units.

To summarize all of the work being done at the Experiment Station would be too voluminous to report and a simple listing of projects would not adequately describe the intent or importance of the program. Therefore, this annual report highlights selected portions of the Experiment Station research program in areas of human health and nutrition, food animals, crop production and protection, forestry, the environment, and alternative crops and resource uses.

Kiwi fruit is one of several alternative crops being tested at the Experiment Station.



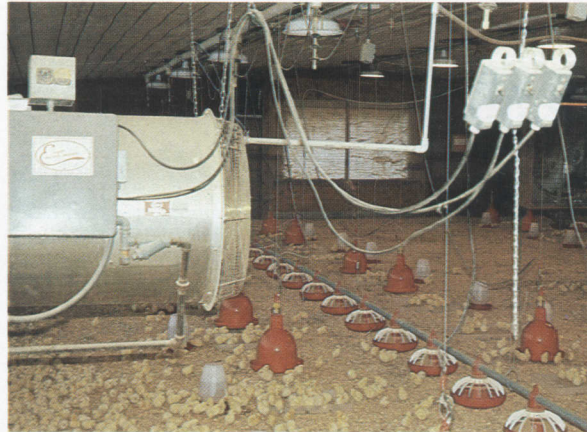
Changes in lifestyle and eating habits of Americans have created a series of revolutionary changes in the meat industry. Poultry capitalized on the link between cholesterol and heart disease to promote their products as being healthy. This, combined with the demand for fast food items and quick fix meats, such as chicken nuggets, franks, and sausage, ushered in an era in the meat industry often referred to as the 'feather revolution'. After initially reacting slowly to these changes, beef and pork producers dispelled many of the rumors about red meat and health problems and brought out a number of lower calorie, lower fat products, such as light beef, beef sticks, and beef nuggets—all a part of the so called 'red revolution'. Currently, fish and shellfish farmers are bringing in the 'blue revolution' in which fish and aquacultural products are raised on the farm to bolster depleted harvests from the sea. Researchers at Auburn are working with all three industries to provide the technology needed to further revolutionize the meat industry in this country.

Determination of Energy Use Efficiency of Four Brooding Systems

Research to compare relative energy use efficiency of traditional pancake infrared, positive pressure (with ventilation preheat), and direct fired-forced air poultry brooder systems was conducted by an interdisciplinary team of scientists. The infrared system consumed the fewest gallons of LP gas for each grow-out period, and had the overall lowest average gas consumption for the entire year. For the first 3 weeks of each trial (normally considered the primary brooding period), infrared usage was lowest for each trial and had the lowest average.

Gas used during the first 3 weeks, as a percentage of the total, ranged from a low of 64.7 percent to a high of 100 percent. Generally, the colder the weather (i.e. winter broods), the lower the 3-week percentage. Average gas consumption per brood varied widely with time of year, with a low of 13.0 gallons per 1,000 birds for the summer trial to a high of 129.2 gallons per 1,000 birds for the winter trial.

Bird weight at 21 days showed an advantage for the infrared system. Energy costs were signifi-



More efficient use of energy in poultry brooder houses saves both energy and production cost.

cantly lower for the infrared, radiant, and forced air furnace than for the positive pressure, with costs being 0.16, .17, .17, and .19 cents per pound, respectively.

Fungus-Infected Fescue Causes Reproduction Problems

Auburn researchers were the first to discover the relationship between reduced beef cattle performance and grazing on Kentucky 31 tall fescue infected with the fungus *Acremonium coenophilum*. Now researchers are discovering that grazing fungus-infected fescue adversely affects reproduction in cattle.

Conception rates of beef heifers receiving low, medium, and high levels of infected fescue were 96 percent, 82 percent, and 55 percent, respectively, the first year and 93 percent, 45 percent, and 33 percent, respectively, when the cattle were rebred. The percentage of infected fescue in the low, medium, and high infected pastures was 0 to 5 percent, 25-60 percent, and 80 to 99 percent, respectively.

Heifers in the medium and high treatment groups lost weight while nursing a calf during the spring breeding season. Milk production declined linearly with increased rate of fungus infection, with the high-infection group being 50 percent lower than the low-infected group. These results indicate that presence of the fungus, *A. coenophilum*, in tall fescue pastures can have a significant economic impact on cow-calf production. For each 10 percent increase in fungus infection, conception rates dropped 3.5 percent and daily milk production decreased by 2.3 pounds.

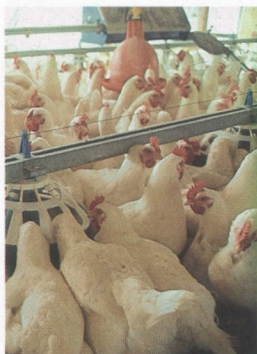


Researchers have found new negative factors caused by grazing heifers on fungus infected Kentucky 31 tall fescue.

New detection technique may eliminate tibial dyschondroplasia that causes lameness and prevents proper nutrition and watering in chickens.

New Drug Proves Successful in Treating Coccidiosis in Pigs

Studies evaluating the effects of the experimental drug amprolium on coccidiosis in suckling pigs indicated that higher dosages appear to protect pigs against clinical symptoms of the disease, but do not totally inhibit excretion of environmental stages of the parasite. There were clearly observable differences in weight gains for pigs treated with amprolium at dosages greater than 10 milligrams per pound when compared to infected, nontreated piglets or infected piglets receiving the drug at lower dosages. Piglets receiving low doses of amprolium (5 milligrams per pound) were less alert, tended to lose weight during the acute phase of the disease, and were more likely to succumb to coccidiosis than those receiving amprolium at higher doses. Tests using amprolium to treat coccidiosis in pigs are important because there are currently no Food and Drug Administration-licensed compounds to treat or prevent the disease.



New diseases, such as avian cryptosporidiosis, are being studied.

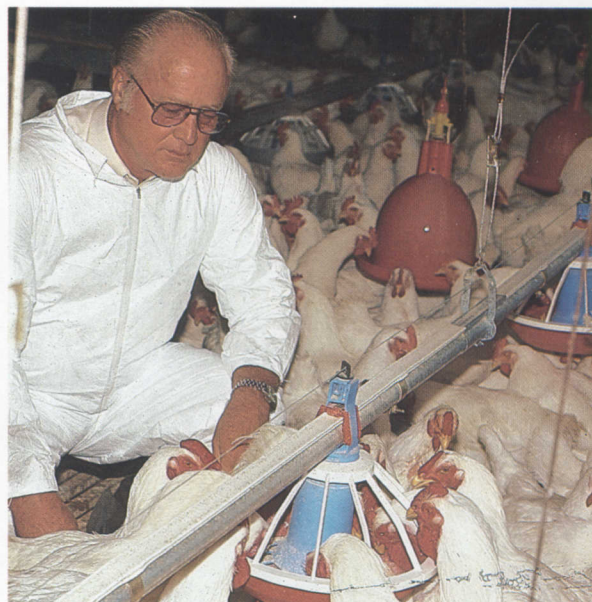
Cryptosporidiosis in Broiler Chickens

Cryptosporidiosis, a disease of the intestines and respiratory system of young chickens, is rapidly becoming a threat to the State's poultry industry. Research indicates the disease is more likely to be fatal to birds with respiratory infections. Infected birds showed reduced weight gain and color loss. The disease is spread more rapidly when found in combination with other poultry diseases.

Attempts to inoculate laboratory mice, cotton rats, and adult male mice failed, indicating humans are not susceptible to the disease. Quail and red-tailed hawks also were not susceptible, but turkey poults, chicken partridges, guinea fowl, common ducks, and ring-necked pheasants were successfully inoculated with the disease.

New Technique Allows Early Detection of Broiler Bone Disease

A technique using a Lixiscope has been developed to detect tibial dyschondroplasia (TD), a disease that causes lameness and subsequently poor production in broiler-breeders. The Lixiscope uses I¹²⁵ as a source of gamma energy, which is converted first to electrons and then to visible light.



The resolution of the images is approximately 4.2 line pairs per millimeter.

The images were interpreted to monitor the development of TD in growing broilers. The left and right femoral-tibial joints were observed at 3, 5, and 8 weeks of age. A subjective scoring system was developed to assess severity of TD. Correlations between the TD scores and lesions were established and confirmed by microscopic examinations. The Lixiscope imaging technique offers quick and noninvasive visualization of TD lesions in broilers, allowing accurate detection of TD in broilers as early as 3 weeks of age. By using this equipment and research data obtained using it in these experiments, breeding stock can be selected to eliminate or greatly reduce the incidence of TD in broiler birds.

Timing of Vaccination Can Reduce Heifer Conception Rate

Infectious bovine rhinotracheitis (IBR) is a herpesvirus infection of cattle that may cause respiratory tract disease or abortion and infertility. The effective use of modified live virus vaccines has gained widespread acceptance in the beef cattle production industry. Recent research has been directed toward determining the effect of these vaccines on the ovaries of cattle.

Virgin heifers experimentally vaccinated during estrus (heat) and pasture bred by proven bulls have been shown to be two times more likely to fail to conceive on first service than matched, unvaccinated controls. The virus infection resulting from vaccination has been shown to cause severe

damage to the ovary and to cause hormonal imbalances that endanger successful conception and maintenance of pregnancy. This research emphasizes that beef cattle producers should assure that cows or young heifers are not vaccinated with vaccines during estrus or immediately before breeding.

Economics of Catfish Egg, Fry, Fingerling, and Food Fish Production

Farm-raised catfish has shown the fastest percentage growth of the nation's food industries throughout much of the last decade. The availability of a dependable supply of eggs, fry, and ultimately 5-inch fingerlings used to stock grow-out ponds is critical to the industry's further expansion.

Recent economic studies found that highest net returns to land and management were in the production of 5-inch fingerlings. The highest return to capital was from fry production. Highest value of production per man-hour was from the production of 5-inch fingerlings. Highest value of production per pound of feed was from fry production.

Economic Development of Poultry Litter for Beef Cattle

About two million tons of chicken litter, which can be processed and used as fertilizer or livestock feed, is produced annually by Alabama's billion dollar a year poultry industry. This by-product, considered an environmental pollutant in past years, represents a valuable resource.

The value of litter as a feed is about 3 to 10 times greater than its value as plant nutrients, and several times its value for production of methane gas. The crude protein content of average Alabama litter is 24 percent, of which 30 percent is true protein and 70 percent is in the form of nonprotein

constituents, chiefly uric acid, urea, and ammonia. Other nutrients in litter include fiber (27 percent) and minerals (22 percent). These nutrients are readily utilized by ruminant animals such as beef cattle.

Researchers have evaluated several processes to enhance the crude protein level of litter, to improve its preservation, and to ensure the safety of litter as a feed ingredient. Litter ensiled with chopped whole corn plants undergoes a lactic acid fermentation process similar to fermentation of corn silage. Because corn silage is low in protein and minerals, and litter is relatively high in these dietary components, the litter complements the nutrient value of corn silage and other forages. The fermentation process has been demonstrated to ensure that litter is safe and will not be a vector for the transmission of diseases.

Dairy Cows Respond Differently to Heat

Heat stress is the major environmental problem facing southern dairymen. A two-year study was conducted to evaluate the effects of high air temperatures on feed intake and to develop equations to describe this relationship in both Holstein and Jersey cows. Milk production dropped in Holstein cows at temperatures above 99.9 degrees F, and in Jerseys at temperatures above 101.8 F. However, feed intake dropped at temperatures above 97.6 F in Holsteins and 93.9 F in Jerseys. Feed intake was more closely related to air temperature in Jersey than Holstein cows. During periods of prolonged high air temperatures, it appears that dairy cattle adapt, and increase feed intake relative to that observed during short periods of high air temperatures. Jersey cattle appear to maintain milk production at higher environmental temperatures than Holsteins.



Alternative grazing and feed supplementation are planned to avoid sending Alabama cattle out of state for finishing.



Catfish fry production could become a big industry in Alabama.

Crop Production and Protection



An Auburn-developed computer program could be used by growers for most efficient and cost effective use of pesticides and crop nutrients.

Field crop farming in Alabama has become risky in recent years. Traditional crops in the State, such as corn, wheat, and soybeans, are no longer as valuable as they once were and acreage continues to drop. Nevertheless, these crops are mainstays in Alabama's agricultural industry. Considerable research time is being spent in efforts to develop more efficient methods for growing these traditional crops. Much of the research being done today is helping row crop farmers survive, but in the future, when these crops are in short supply and demand and prices are good, this technological edge could mean an economic boom to the State's farmers.

AUSIMM Computer Model Predicts Soybean Disease and Insect Problems

Soybean farmers in Alabama have been faced with a considerable problem in attempting to manage their soybean diseases, despite crop values of only \$5.00 per bushel. Usually this has meant that farmers have ignored diseases and hoped that their losses would not be too great. To help resolve this problem and to provide growers with the necessary information to accurately predict disease severity and the profitability of any control practices, Experiment Station researchers have developed computer software that will soon become available.

For diseases of pods, stems, and leaves, the program requires the farmer to enter the daily weather and the 5-day forecast after his soybeans

have begun to bloom. Weather data plus information on the variety planted, the productivity of the field site, and the previous rotational history allows a computer to provide information on the profitability of controlling these diseases with aerially applied fungicides. Preliminary tests conducted at 17 sites during 1986 indicated a high degree of accuracy except when yields were ruined by late season droughts.

A second portion of the computer disease program provides the ability to predict stem canker epidemics. The farmer is advised by the computer of the susceptibility of over 120 varieties to the stem canker fungus; it will also tell him if these same varieties are susceptible to five different nematodes. The computer has been programmed to know that the soybean plant is most susceptible between the 2-leaf and 6-leaf growth stages. If the farmer has planted a susceptible variety, and weather conditions are appropriate for infection during these growth stages, the program will advise fungicide sprays.

The midseason disease (leaf, stem, and pod) and stem canker models have been added to an overall computer program that also contains nematode and insect management models. Together these comprise a computerized soybean pest management model that aids the soybean farmer in making decisions based on the profitability of controlling pests. The pest management program has been named AUSIMM, for the Auburn University Soybean Integrated Management Model.

Biological Methods Used To Control Nematodes

Nematodes, microscopic parasites that attack plant root systems, cause tens of millions of dollars of damage to Alabama crops annually. Several of the most effective chemical nematicides have been banned and environmental concerns have led researchers to look for biological controls and alternative rotation crops to break up nematode cycles.

Results of Experiment Station research using biological control of nematodes in 1987 were encouraging. In previous years, a chemical found in waste products of the shell-fish industry, called chitin, showed the potential for nematode control.

Various preparations of chitin, when incorporated in soil, stimulate the activities of a microflora antagonistic to nematodes. Chitin preparations were evaluated in the field for control of root-knot nematodes on a variety of vegetable crops. Several chitin preparations were as effective as labelled chemical nematicides in controlling nematodes and increasing yields, demonstrating for the first time that biological control of nematodes is a practical and profitable proposition. There is commercial interest in these chitin preparations and it is expected that a formulated product will be available for widespread testing in 1988.

A number of crops not common to Alabama farmers were evaluated for their ability to reduce plant parasitic nematodes when used in crop rotation. The most effective were sesame, American joint vetch, castor bean, hairy indigo, and partridge peas.

New Viral Plant Disease Threatens Alabama Crops

The first significant outbreak of tomato spotted wilt virus (TSWV) in Alabama occurred in 1986 in peanuts and tomatoes. Although general incidence was low, there were some instances of heavy losses to the virus in tomato and peanut production areas. TSWV-infected peanut plants were found in 51 of 54 fields surveyed in nine major peanut-producing counties. Tomato plantings were not surveyed; however, TSWV was diagnosed in samples received at the Plant Diagnostic Laboratory from 34 counties throughout the State.

In view of this potentially serious problem, a team of research scientists was quickly mobilized, and a number of experiments were initiated for the 1987 crop season. These include efforts to monitor populations of thrips, the vectors of TSWV, and to survey major peanut and tomato production areas for the virus, as well as tests to evaluate insecticides, dates of planting, and varietal resistance for controlling the virus. Survey results showed that incidence of TSWV in Alabama declined sharply in 1987. For example, the virus was found in peanuts in 9 of the 10 counties surveyed, but only in 27 of 65 fields and at an average incidence of only 0.02 percent; the highest incidence found in any field was 0.27 percent. Although TSMV was far less prevalent and damaging in Alabama crops than anticipated, the continued presence of the virus in the State signals a clear potential for serious outbreaks in coming years.

Protein Binders May Explain Resistance to Herbicides

Weeds are among the most limiting obstacles to plant crop production. Of major concern to both farmers and chemical manufacturers is the acquired tolerance by some weed and grass species to chemical herbicides. Biotechnologists are using photosynthetic bacteria as a model system to study the ways herbicides inhibit growth of photosynthetic organisms and how these organisms develop resistance to certain herbicides.

Researchers have identified the specific proteins in the photosynthetic membranes of bacteria which bind herbicides such as atrazine and diuron, thus preventing the conversion of solar energy into cellular chemical energy. It has been shown that resistance to these chemicals can result when there is a mutational change in the genes encoding for these proteins, and the organism produces a slightly altered protein. These "mutant" proteins can act normally in solar energy conversion, but they no longer interact with the herbicides. Therefore, these herbicide-resistant organisms can grow in the presence of normally toxic concentrations of herbicide.

Long range goals of this work are to identify mutational changes which allow herbicide resistance, but which do not lower growth capabilities of the organism. Such identified genes might then be transferred into crop plants such as soybeans, by using the techniques of modern biotechnology, to increase the spectrum of use of herbicides in agriculture.

Different Species of Weed Group Require Different Herbicides

The need for defining efficacy of chlorimuron herbicide on the pigweed group (*Amaranthus* spp.) became evident during the 1986 crop year



Tomato spotted wilt virus was widespread, but not severe in Alabama in 1987.

Several Experiment Station projects are aimed at developing more efficient biological and chemical control of peanut pests.

when variable control resulted from postemergence application. Research was initiated with the objective of defining efficacy of chlorimuron when applied postemergence to different pigweed species common to the Southeast.

Weed seed planted for the tests included smooth pigweed, redroot pigweed, and spiny amaranth from Alabama, Palmer amaranth from Georgia and South Carolina, and slender amaranth from one site in Jay, Florida.

Chlorimuron provided 83 to 97 percent control of smooth and redroot pigweeds that were collected from Alabama when applied at 1/8 ounce active ingredient (a.i.) per acre and pigweeds had three to four leaves. However, lower (83 percent) control was evident for the Alabama spiny amaranths. Few differences were evident among the various collection sites.

Good control (85 percent) of all Palmer amaranth was obtained with chlorimuron applied at 1/16 ounce a.i. per acre to plants with three to four leaves. The higher 1/8 ounce a.i. per acre rate provided excellent (97 percent) control. Applying the same rates to larger eight-leaf plants reduced control to poor (65 to 69 percent) for both rates. No differences were evident in control due to collection sites. Regardless of the stage of growth or chlorimuron rate, the slender amaranth collected from Jay, Florida, was poorly controlled (65 percent or less).

These data show the need to correctly identify pigweed species that are to be treated with chlorimuron. It is not the best herbicide choice for controlling spiny and slender amaranth. Spiny amaranth is found throughout Alabama in infestations dense enough to require treatment. Slender amaranth is found throughout Alabama, but infestations dense enough to require treatment are found mostly along the Gulf Coast.

Herbicide Stunting of Weeds Effective and Economical

Two applications of either chlorimuron or imazaquin herbicide have been shown to provide acceptable sicklepod weed control; however, this control is too expensive, considering current soybean prices, and sometimes soybean injury is unacceptable. Since a single foliar application of either herbicide causes moderate to severe stunting of sicklepod, research was designed to determine how competitive stunted sicklepod is in soybeans.

Variables included two herbicides, chlorimuron and imazaquin, and five sicklepod densities: 0, 2,

4, 6, and 8 plants per 3 feet of row. Plot size was three 36-inch rows by 50 feet in length of Braxton soybeans. Sicklepod seed were planted within 3 inches on both sides of the soybean drill of the center row and then thinned to the above desired densities. chlorimuron and imazaquin rates high enough to stunt, but not enough to kill, sicklepod were used.

Sicklepod dry weight was affected by sicklepod densities and herbicides. Dry weight increased with each increase in sicklepod density. Imazaquin, when averaged over densities, reduced sicklepod dry weight by 48 percent, while chlorimuron reduced sicklepod dry weight by 81 percent. Soybean seed yield decreased as sicklepod density increased up to six per 3 feet of row. Chlorimuron produced higher soybean yields than imazaquin, but use of either gave yields higher than the no herbicide treatment.

This research shows that stunting of sicklepod with a single application of chlorimuron or imazaquin allowed the soybeans to canopy-over the smaller weeds, thus rendering them less competitive.

Tillage Model May Lower Fuel Production Costs

Increasing production and decreasing production cost is the dilemma of virtually every row crop farmer in America. Recent Experiment Station research indicates that reducing adhesion of soil to plow and decreasing sliding resistance of tillage tools can dramatically reduce tillage cost.

Sliding resistance is frictional in nature; however, the frictional behavior may be complicated by adhesion between the tool surfaces and the soil. This adhesion is due to the attraction of the soil water to both the tool surface and the soil particles. In some cases the soil sticks to the tool surfaces and does not scour, which impairs effective tillage implement performance. Sliding resistance may account for as much as 50 percent of the total energy; thus, a reduction of sliding resistance translates into decreased energy requirements and lower cost of production.

Cooperative research with the USDA-ARS National Soil Dynamics Laboratory resulted in the development of a mathematical model of sliding resistance between soil and steel. The model predicts sliding resistance as a function of applied normal stress and sliding path length, and as expected, the model depends on soil type and soil moisture. Within the soil moisture content range for a given soil that is desirable for tillage operations there appears to be an optimum moisture



Researchers found that different pigweed species react differently to herbicides.

content that minimizes sliding resistance. Thus, tillage at this optimum moisture content may require less energy and reduce production cost.

Deep Tillage Proves Best For Double Cropped Rye

Rye, used both for winter grazing and to break up disease and nematode cycles in subsequent summer crops, is a popular off-season crop in Alabama. To provide more information on tillage requirements of rye, tillage studies were established on a Dothan fine sandy loam at Headland, Bennedale coarse sandy loam at Brewton, and Lucedale fine sandy loam at Monroeville.

The tillage treatments consisted of no tillage, disk only, chisel plow, turn plow, and subsoiling prior to planting the rye. Rye was drilled in the fall of 1986 after harvesting grain sorghum which was no-till planted with and without in-row subsoiling. The rye was cut for forage yields in early March.

The rye forage yields followed the same trends as wheat grain yields in previous years in that no-tillage resulted in the lowest yields (up to 3,800 pounds per acre). Disking only improved yields as much as 1,110 pounds per acre over no tillage, but resulted in lower yields than deep tillage (which ranged up to 5,700 pounds per acre). No one form of deep tillage was generally superior to the other. Although in-row subsoiling for the summer crop improved yields at Brewton, the improvements

primarily occurred within the no-tillage and disk-tillage systems, and it would not substitute for deep tillage prior to planting rye.

Results from the first year of this test strongly indicate that no-tillage is not an acceptable production practice for rye on sandy Coastal Plain soils, especially when the cost of a no-till grain drill is figured into production costs. Data indicate when purchase price of equipment and cost of tillage operations are considered, the most economical system would probably be chisel plowing, an acceptable form of conservation tillage on most soils.

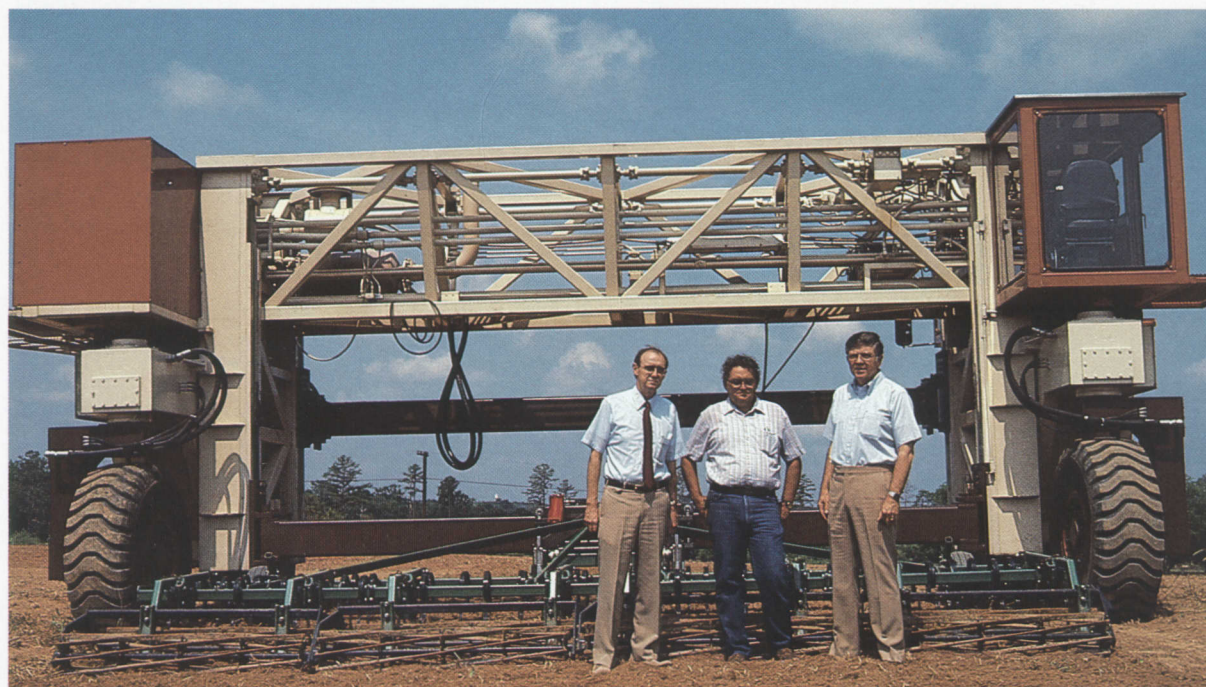
Fertility Tests May Eliminate Calcium Overuse In Peanuts

Peanuts grown in Alabama's Wiregrass area show a higher propensity for calcium deficiency than other crops. Thus, calcium fertility is the most important soil fertility factor for peanut production. Currently, the Alabama Crop Improvement Association requires that peanuts grown for certified seed receive a 500-pound-per-acre application of gypsum regardless of the soil-test level.

Auburn researchers have successfully determined critical soil-calcium levels for maximum yield of peanuts. Early indications are that seed calcium levels can be used to predict germination quality. The germination data will ultimately allow for the correlation of calcium seed content and soil-calcium levels so high quality certified seed peanuts can be produced without unnecessary applications of calcium.



Fertility studies could help peanut growers avoid overuse of calcium.



Modern tillage equipment, such as this wide body research tool, is being used to find answers to age old problems of efficient soil preparation.

Molybdenum Deficiency Widespread in Alabama

Because previous liming experiments in northern Alabama were unsuccessful in establishing the critical soil pH level for soybeans, on-farm experiments were initiated to delineate the separate effects of likely acid-soil infertility factors. Molybdenum deficiency was found to be a limiting growth factor in 5 of 15 experiments, while aluminum

alone or both aluminum and molybdenum were found to decrease yield in six other soybean fields.

These results indicate a previously unreported widespread molybdenum deficiency. Results from two 2-year rotation experiments at the Tennessee Valley Substation indicate that this increase in molybdenum deficiency may be related to the lack of molybdenum as a contaminant in high purity phosphorus fertilizers that are being used.

Human Health and Nutrition

Fish may be used as research animals in man's quest to conquer cancer.

Research in the Alabama Agricultural Experiment Station includes projects in the schools of Forestry, Agriculture, and Human Sciences and the colleges of Veterinary Medicine and Science and Mathematics. Research in some of these areas directly affects human health and nutrition, but research in all areas indirectly benefits these two basic human needs. Agricultural research in particular has played a key role in the development of modern medicine. Benjamin Minge Duggar, an early Auburn researcher, for example, discovered the antibiotic aureomycin. Key pieces in the gigantic puzzle of finding cures for cancer and AIDS will no doubt come from agricultural experiment stations at land-grant universities across the country.

Fish Provide New Assays For Chemical Carcinogens

Several species of fish are potentially valuable as research animals in human cancer research. Fish develop neoplasms (cancers and benign tumors) after exposure to a variety of known carcinogens, and for some fish the neoplastic responses to chemical carcinogens resemble those of rodents which are usually used for this type of research. Two major advantages to the use of fish rather than rodents as assay animals are evident: neoplasms can develop in less time, and spontaneous neoplasms, which are common in rodents, are rarely found in fish.

Research was conducted at Auburn to determine the types of neoplasma resulting from injection of *N*-methyl-*N'*-nitro-*N*-nitrosoguanidine (MNNG), a known carcinogen, into gulf killifish embryos. Ultimately results of this research could be used in a method for assaying chemicals for car-



cinogenicity. The test chemical was injected into the yolk sac of embryos, while control fish were injected with DMSO, a solvent used to dissolve the MNNG.

Of the six fish examined, one had a malignant neoplasm. This was a pancreatic acinar cell carcinoma which had invaded the posterior liver. There are only two previous reports of pancreatic neoplasms induced in fish by chemical exposure. The use of fish embryo exposures seems promising as a method to induce pancreatic tumors which could be used to resolve questions about histogenesis of exocrine pancreatic carcinomas in man.

Natural Plant Compounds May Help AIDS Victims

Auburn research aimed at providing new sources of plant chemicals to fight viral, fungal, and bacteriological infections in chickens may provide some new and readily available compounds to fight secondary infections that occur in many AIDS patients.

Naturally occurring plant chemicals were assayed for biological activities against bacterial, fungal, protozoan, and viral pathogens of chickens. Preliminary results were confirmed that several chemical fractions of the genus *Larrea* were highly active and that novel compounds are potentially available from natural sources. Data indicate that these novel compounds are also active against the opportunistic secondary infections which occur in AIDS patients. These compounds were very active against mycobacteria, *Cryptococcus neoformans*, and cytomegalovirus.

Vitamin E: No Miracle Cure for Heart Disease

Vitamin E has more unfounded claims concerning what diseases it can cure or prevent than any other vitamin. Ads for vitamin E have depicted it as a "panacea for whatever ails you" from heart disease to cancer to sexual impotency. Experiment Station researchers have been investigating the claim—that supplemental vitamin E can prevent or at least ameliorate cardiovascular disease.

If platelets, or cells in the blood stream, become too sticky, an unwanted blood clot can form, and if the clot blocks one of the vessels in the heart, a heart attack can occur. The stickiness, or aggregability, of blood platelets depends in part on the balance of thromboxane, which promotes platelet aggregation and causes constriction of blood vessels, and prostacyclin, which inhibits platelet aggregation and causes blood vessel passages to widen. One proposed way in which vitamin E is believed to promote cardiovascular fitness is by lowering thromboxane or raising prostacyclin in the blood stream so that blood clots would be less likely to form.

Hamsters were chosen for the study because they are similar from a cardiovascular standpoint to humans. One group of animals was fed a normal amount of vitamin E; another group was fed high levels of the vitamin. Blood samples were



Research on livestock and plants often results in benefits to scientists studying human health problems.

taken and the amounts of both thromboxane and prostacyclin in the blood were measured. No differences were seen in either of these compounds between the normal group and the vitamin E-supplemented group. These results did not support the claims that vitamin E supplements would help to prevent or lessen heart disease through changes in levels of thromboxane and prostacyclin.

Selenium Proves Important In Infant Eye Development

The retina in the eye develops to maturity during the last trimester of pregnancy and during the first few months postnatally. During this time, the eye needs proper nutrients which are provided by the mother through the placenta. Advances in medical technologies have greatly increased survivability of immature premature infants. However, the infant's nutrition is provided artificially, and because of the many complications due to prematurity, the infant has significant complicating medical problems.

Experiment Station researchers are studying one disease, retinopathy of prematurity (ROP), that has become common in infants born 2 or more months premature. If untreated, ROP may cause a permanent loss of vision. The selenium-containing enzyme, glutathione-peroxidase, is an antioxidant found in the retina of developing infants. From research in collaboration with the Cullen Eye Clinic and Baylor College of Medicine, Auburn researchers determined that in the retinas of infants born alive at less than 28 weeks of gestation, but who subsequently died, the selenium antioxidant system is active. Thus, there is evidence to suggest that selenium may be important for the retina of the extremely premature infant.

Auburn researchers evaluated selenium-containing enzymes in the eye of laboratory rat pups and the effects of various chemical forms of selen-



Efficient control of roaches could save homeowners millions of dollars.

ium on eye glutathione-peroxidase activity. Selenium appears in many chemical forms. Selenite is the salt form found in lava rock and possibly in some plants. Selenomethionine is found in plant proteins like soybean protein and is an amino acid form. Another amino acid form, selenocystine, is found in animal proteins such as beef and poultry.

This research showed that additional dietary selenium improved the antioxidant properties of the eye by improving the level of glutathione peroxidase. Also, during nursing, selenomethionine was a better form than selenite. After the eye finished developing, at 14 days after weaning, there was no difference between selenite or selenomethionine, but selenocystine was a poor form of selenium. When the rats reached 21 days postweaning there were no differences between forms of selenium. These data suggest that the form of selenium may be more important while the eye is developing, suggesting that if selenium is administered to a premature infant, selenomethionine, the form found in plants, might be the form of choice.

Chemical Baits Can Control Disease-Carrying Roaches

Cockroaches are one of the most common carriers of human diseases. Though Americans spend an estimated \$15 million annually to control

these pests, cockroaches have been around since prehistoric times and have developed an uncanny ability to build up resistance to chemical insecticides. Recent research at the Experiment Station indicates that roach baits can be effective for long-term control of cockroaches, but only if the right baits are used.

Recent studies have evaluated the effectiveness of several bait formulations for indoor German cockroach control. Twelve bait trays were positioned in kitchens and cockroach populations monitored for 12 weeks. None of the formulations provided control at 1 week, but Combat® provided superior control between 2 and 12 weeks, with average population reduction of about 85 percent.

Large Turkeys Lower in Calories

Modern processing technology provides the means of incorporating meat from other parts of chickens and turkeys into breast roasts. While this may reduce the cost of the roast, it also increases the amount of fat and calories, according to Auburn researchers.

Large-type hen turkeys and small-type toms were marketed at 14 weeks and processed into breast roasts to examine cooking characteristics and composition. Larger hens have more fat in the body cavity than small toms and this extra fat shows up in the drip upon cooking and as added fat content of skin and meat. Inclusion of thigh meat in the roasts accentuated these differences.

Meat pH Influences Precooked Roast Color

Because of the recent interest in convenience foods, precooked meat products such as precooked roast meat and precooked steaks have enjoyed considerable success in the market place. One of the drawbacks to the successful marketing of these products is that there is considerable variation in the color of these products. Research on this subject at Auburn University has found that the difference in color between precooked meat products cooked to identical internal temperatures is due to variation in the pH of the meat used. For example, when cooked to the same temperature, meat with pH above 6.50 was considerably redder than normal pH (5.50) meat and appeared undercooked. This same effect was observed with beef, pork, and turkey meat.

Researchers study relationship between pH and meat color.



A critical issue facing Alabama is the prevention of contamination of streams and impoundments and regulation of the use of water to conserve it for future generations. Failure to understand and solve water use problems could lead to Federal guidelines in the future that would make both agricultural and consumer utilization tightly regulated. Wildlife and plant species so critical to the overall environment must also be understood and managed so that future generations can enjoy them. Environmental issues are at the forefront of many Experiment Station research projects. The environmental need to maintain a chemically uncontaminated water supply and the economic need of farmers to reduce production costs by reducing chemical use run parallel.

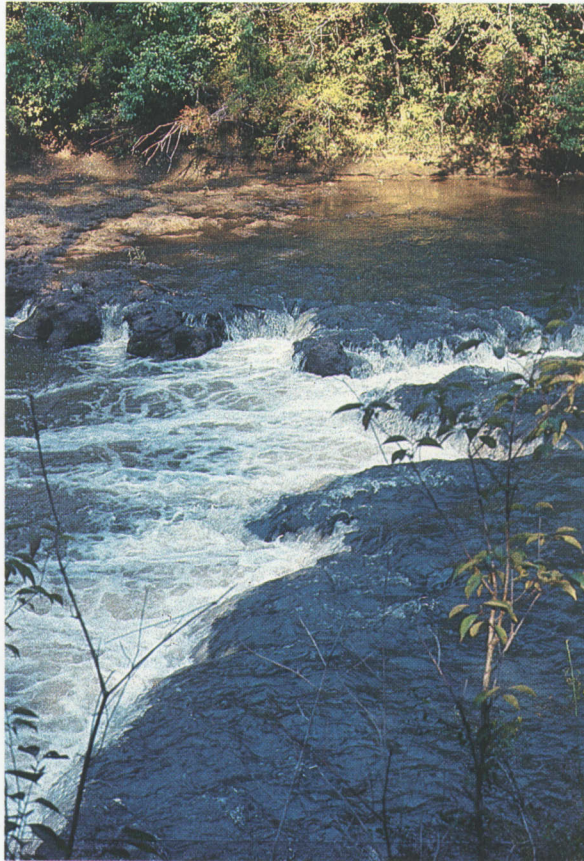
Recreational Use of Alabama Streams

Alabama is blessed with approximately 3,200 miles of rivers, plus about 11,000 miles of other major streams. Most of the State's large flow waterways have been impounded for navigation, electric power generation, or both. Impoundments resulted in loss of natural river flows but created lakes that have become popular recreational resources. Remaining free flowing streams are popular for boating, white-water canoeing, and recreational floating or fishing.

A survey of 723 Alabama households provided insightful information for the most popular rivers. These included Locust Fork of Black Warrior River, the Cahaba River, West Fork of the Sipsey River, the Little Cahaba River, and Little River. Survey results indicate that both recreationists and nonrecreationists were willing to pay to maintain the study rivers in their natural condition.

Emergency Planning for Hazardous Waste

Contemporary emergency planners confront numerous planning problems and issues. Technological progress has brought with it vulnerability to new sources of man-made danger, including explosions, radioactive contamination, and catastrophic accidents involving toxic and carcinogenic chemicals, to name a few. Experiment Station re-



Alabamians favor development of recreational sites, such as shown here at Pea River Falls, along the State's waterways.

search was carried out to evaluate the problems faced and the emergency planning and preparedness in the Sumter County, Alabama, area, where the Emelle hazardous waste storage facility is located.

Research disclosed the need to establish comprehensive plans that can be reviewed on an annual basis. Though there was a lack of sufficient personnel and equipment to respond adequately to an emergency situation, organizational officials were quite knowledgeable of their respective domain responsibilities. Research indicated a need for increased public awareness and involvement in emergency planning and increased emphasis on mitigation and recovery. Organizations such as urban planning boards and public welfare services were encouraged to be more fully integrated into the emergency response system.

Dove Diets a Factor in Lead Shot Poisoning

Mourning doves, Alabama's most heavily hunted game bird, are vulnerable to lead shot



Emergency planning for hazardous waste disposal sites, such as shown here at the Emelle, Alabama, facility, is being studied.



Mourning doves, Alabama's most heavily hunted game bird, is susceptible to lead shot poisoning.

ingestion because they are hunted in fields where they feed. Substantial amounts (up to 1 per square foot) of spent lead shot are available at, or near, the surface of recently hunted dove fields. Up to 6.5 percent of the mourning doves collected from dove fields have ingested lead shot present in their gizzards. When mourning doves are experimentally dosed with lead shot they show characteristic symptoms of lead toxicosis and those maintained on a high corn diet and subjected to winter weather conditions suffer high mortality. Consequently, Alabama Agricultural Experiment Station researchers designed an experiment to delineate the relationship between diet, cold exposure, and lead toxicosis in female mourning doves.

In the test, 96 doves were fed a pelleted ration or mixed seed, with and without lead shot added. The birds were also grouped according to temperature, confined individually, and acclimated to their respective diets and environments 3 weeks prior to dosing.

No mortality occurred during the experiment, nor were there differences in body weights between lead-treated doves and controls. Tissue lead levels were higher in lead-dosed birds than controls. Partially eroded lead shot were recovered from feces in 89 percent of the lead-dosed doves. Doves on the pelleted diet retained lead shot longer and eroded more lead than did doves on the mixed seed diet. There were no differences in tissue lead levels due to temperature.

Tissue lead levels, especially in the kidney, were higher in doves on the mixed seed diet, although greater erosion of lead occurred in doves on the softer pelleted diet. The increased likelihood of shot expulsion in the mixed seed diet was apparently offset by nutritional and/or other factors which increased lead absorption and/or retention in body tissues.

Susceptibility to lead toxicosis in mourning doves apparently depends on the amount of exposure to lead shot and the composition and nutritional content of mourning dove diets in the wild.



Finding a herbicide to control weeds in woody ornamentals would provide economic relief for nurserymen.

Artificial Light Spurs Growth, Limits Cold Hardiness of Plants

The growing period of many of Alabama's most popular ornamental plants, such as azaleas, boxwood, crapemyrtle, and several hollies, may be extended by exposing these plants to artificial light. While this lengthens the growing season and potentially shortens the production time, it also de-

lays dormancy, which exposes the plants to possibly greater winter damage.

To determine the effects of extending the light period, 13 species of temperate landscape trees and shrubs grown outdoors at the Ornamental Horticulture Substation in Mobile, from March 26, 1985, until June 5, 1986, were exposed to natural (NP), night interrupted (NI), or extended (EP) photoperiods from June 21 until November 15.

Subfreezing temperatures were experienced 24 times, beginning December 3 and ending March 22. The total number of hours below freezing was 206 and the minimum temperature was 3°F. Plants of abelia, Florida and Fashion azaleas, cleyera, and redbud exposed to EP and NI during fall 1985 exhibited extensive twig dieback on June 5, 1986. Shoots of crapemyrtle were either killed to the ground (with new growth emerging from the base) or the entire plant killed (57 percent mortality under EP, 29 percent under NI). Fourteen percent of cleyera and redbud receiving EP and 14 percent of cleyera under NI were also killed.

Growth by June 1986, as determined by growth indices, height, caliper, and relative root density, was either greater under NP compared to EP and NI or similar except for caliper growth of crapemyrtle and relative root density of redbud. These results may be explained by the winter injury sustained by many species exposed to long day lengths or by a negative influence of long days in the fall on growth during the spring months.

Herbicides Evaluated for Nutsedge Control and Ornamental Phytotoxicity

Yellow nutsedge is a primary weed problem for nurserymen and homeowners in the United States and has been reported in all but one of the 48 contiguous states. Under noncompetitive conditions of adequate light and moisture, a single plant is capable of forming several thousand tubers in a season. Cultivation and hand hoeing is only marginally effective and no herbicides are currently available to kill the weed without damaging nursery plants.

Experiment Station research evaluated fomefafen, imazaquin, and chlorimuron herbicides, none of which are labelled for use on ornamentals, for control of yellow nutsedge and for phytotoxicity to four ornamental species.

With respect to phytotoxicity, neither Big Blue liriopie nor common boxwood exhibited injury symptoms from any of the herbicides at 8 weeks.

Imazaquin at all rates suppressed growth of Natchez crapemyrtle and Copperman azalea. Phytotoxicity symptoms were characterized by stunted plants with lanceolated leaves arising in a fashion similar to a witches broom. Fomefafen at all rates initially showed some chlorotic spotting on all ornamental species; however, at 4 weeks all species grew past the injury. Chlorimuron at the 2X rate initially caused stunting of growth in Natchez crapemyrtle and Copperman azalea, but by 8 weeks these plants were similar to the control plants.

Chlorimuron at 0.25 and 0.75 ounce active ingredient per acre was safe on all four ornamental species tested, with the 0.75- and 1.0-ounce rates applied pre-plant incorporated and preemergence providing excellent yellow nutsedge control. Chlorimuron, though not currently registered for use on woody nursery stock, appears to be a promising herbicide for yellow nutsedge control.

Study Shows Alabama Bears Live in Harmony with Man

The black bear, *Ursus americana*, is distributed over all of Alabama. It is most abundant in the southwestern counties, Baldwin, Mobile, and Washington, and it occurs much less frequently elsewhere in the State. It is classified as a game animal with no open season, also as a species of Special Concern, because so little is known about bears in Alabama.

Because of the lack of knowledge, a joint study of bear ecology was initiated by the Alabama Department of Conservation and Natural Resources and the Agricultural Experiment Station. The study was conducted in the Hell's Creek Swamp area, northwest of Saraland, an area of about 25 square miles of uplands and swamps. A number of gas wells are present in the area and the Mobile Water Canal passes through one side of the site.

In the uplands a mixture of pines, oaks, gums, and various shrubs is the predominant vegetation, while in the swamps a mixture of gums, cypress, and titi shrubs form a dense barrier to man's movements. Many of these berry, acorn, and nut producing trees furnish the main foods of the bears.

Five bears were captured, measured, and fitted with radio collars, and their movements were tracked for almost 2 years. In general, the bears showed activity from mid-April throughout the summer and fall. From late December through most of March they were inactive and moved little. Also during this inactive period deer and turkey



hunters were present in the area and the bears stayed in the protective swamps. At least five bears other than those captured were present in the 25-square-miles site, making the population as dense as is found in most good bear country.

None of the marked bears was accustomed to people and most people in Saraland and Mobile did not know the bears were present. The Experiment Station study shows that black bears, if they have tree species that supply berries, nuts, and acorns as a food supply, can live near people harmoniously. They must also have some dense vegetation where they can seclude themselves from people and dogs.

Black bears were found to live in harmony with man, if the proper environment is available.

Unique Turf Weed Under Investigation

Virginia buttonweed (*Diodia virginiana*) is a serious weed problem on golf courses and other turf areas in the Southeast. Research indicates that one reason for this weed's success is its ability to propagate itself by various methods. In addition to the aboveground organs, plants of Virginia buttonweed maintain an extensive branching system of thickened roots. These roots bear large numbers of buds, which, under proper conditions, can grow into new shoots. Research at Auburn University's rhizotron have shown that such buds can be produced by roots even at a depth of 3 feet.

Some of the underground buds do not produce shoots, instead they develop into flowers. These unusual subterranean flowers develop seeds

Growth regulators were used to develop 'prescription trees'.

which may provide dormant propagules deep in the soil. Future soil disturbance might bring these seeds to the surface where they could germinate.

Understanding these various mechanisms for reproduction will make control of the weed less difficult. Researchers are screening chemical herbicides for use on Virginia buttonweed, but a virus that infects many populations may prove more efficient in controlling this pest.

Weed Control Improves Bass-Bluegill Fishing

The advantages of fertilizing farm ponds to promote optimum fishing have been recognized throughout the Southeast since the late 1930's. Until recently, however, the interactions associated with largemouth bass predation and bluegill feeding efficiency have not been documented.

Recent Experiment Station studies demonstrated that fewer bass can be harvested in "weedy" ponds because more are needed to control bluegill numbers. Bluegill growth is rapid in fertilized ponds without "weeds" because they apparently feed more efficiently on easy-to-catch crustaceans and insects. This research further demonstrates that fish populations in farm ponds where rooted aquatic vegetation is controlled through fertilization produce the greatest benefits.



Growth Regulator Helps Urban Tree Management

In urban and rural areas trees absorb sound, reduce noise pollution, provide shade, and generally improve the quality of life. In both settings trees can be an expensive nuisance by growing into power lines, costing utility companies millions of dollars annually. Experiment Station research has demonstrated a practical solution to this problem. Use of an experimental growth regulator on red maple resulted in shorter and more compact trees than untreated trees over a 3-year period. Spring greening and fall leaf coloration were not adversely affected by the chemical. Such findings may lead to substantially less pruning by utility companies and allow greater flexibility when landscaping an urban landscape.

Alternative Crops and Resource Uses

New Auburn-developed plum varieties offer hope to commercial and roadside producers in the State.



Traditional Alabama crops, such as corn, soybeans, wheat, and grain sorghum, are not as profitable as they once were, leading many farmers in the State to seek alternative farm enterprises. Experiment Station research is currently evaluating new crops for the State, such as kiwi fruit, passion fruit, pepino dulce, and feijoa. Also getting major attention are catfish and other aquacultural crops that are particularly well suited to Alabama's climate and for which market demands are heavy for domestically produced products once harvested from the sea. Development of alternative farm enterprises and resource uses is a multi-faceted problem that requires researchers to carefully monitor each segment of the State's agricultural economy, so that positive changes made in one place do not cause negative changes in others.

New AU Plum Varieties Offer Commercial Hope

Disease is a major factor limiting commercial production of plums in Alabama. Plum leaf scald, black knot, bacterial canker, and bacterial spot are four of the most serious diseases. Severe crop losses, reduced yields, and tree mortality have resulted from these diseases in certain orchards in Alabama, making commercial, roadside stand, and pick-your-own supplies of plums unstable from year to year.

The plum breeding program at the Experiment Station has utilized sources of resistance in varieties and feral species to develop multiple disease resistant seedlings. Four seedlings from this program, AU-Amber, AU-Rubrum, AU-Rosa, and AU-Cherry, are currently being released. These varieties combine disease resistance with ability to produce high yields of excellent quality fruit.

Skin color of AU-Amber is dark red to purple and the flesh is yellow to amber. AU-Rubrum produces large fruit with red skin and flesh which has excellent storage and shipping quality. AU-Rosa is a mid-season plum, with large dark red to purple skinned fruit and excellent storage and shipping quality. AU-Cherry, a late to mid-season plum with small red skinned fruit, will likely be grown only for home production because of small fruit size.

Giant Australian Crayfish for Alabama Farm Ponds

A large Australian crayfish may add a new dimension to aquaculture in Alabama in the coming years. This freshwater crustacean with maximum size of over 1 pound comes from temperate regions of Australia where the climate is similar to that of Alabama. Other than its large size, the crayfish is similar to our native crayfish. A major difference is that it does not burrow. It eats a wide variety of foods, and has a simple life cycle where eggs hatch directly into small, juvenile crayfish. This would mean no sophisticated hatchery is required to raise delicate larval stages as is the case for freshwater shrimp.

Initial rearing trials at Auburn indicate that these giant crayfish readily eat and grow well on pelleted fish feeds. Low temperatures which occur during Alabama winters appear to cause no problem for the crayfish; however, increased mortality did occur during summer. Research is underway

to determine the optimum temperature range as well as other environmental requirements for good growth and survival.

Fish Grown in Cages A Promising Enterprise

Results of recent research show that filter feeding Chinese carp can be raised successfully at high densities in cages suspended in catfish ponds with plankton or single-celled plants and microcrustaceans as their only source of food.

In the Experiment Station study, hybrid Chinese carp (bighead carp x silver carp) were raised in covered, nylon net cages suspended in catfish ponds in 1986 and 1987. The caged fish received no feed. The only source of food was plankton in the water. In 1986, carp averaging 0.2 pound each were stocked in ten, 0.5-cubic-yard cages at 12, 24, 48, or 96 fish per cubic yard. The fish grew to an average 2.12 pounds at the 48 per cubic yard stocking rate and 1.50 pounds at the 96 per cubic yard stocking rate (1,250 percent and 900 percent weight increases, respectively). Total weights per cage averaged 97 pounds and 140 pounds per cubic yard, respectively. In 1987, 0.6-pound carp were stocked at a rate of 41 fish per cubic yard in 2.5-cubic-yard cages. In approximately 200 days, fish grew to an average of 3.8 pounds (625 percent increase) with a yield of 156 pounds per cubic yard.

Herbicides Offer Good Control Of Weeds in Alabama Strawberries

Weed competition is a major limiting factor in commercial strawberry production in Alabama. To combat this problem, field herbicide experiments were conducted in 1986 and 1987 to evaluate the effects of acifluorfen, chloroxuron, 2,4-DB, lactofen, and fomesafen herbicides on control of Florida pusley, coffee senna, morningglory species, sicklepod, prickly sida, common purslane, large crabgrass, goosegrass, and response and yield of strawberries. Field treatments consisted of combinations of the herbicides with and without chloroxuron and greenhouse treatments consisted of three rates of the herbicides, plus one rate with 1 percent surfactant, volume for volume, added.

All postemergence herbicide treatments caused some injury, but level of injury for all treatments was within acceptable limits. Early broadleaf weed



Finding the proper herbicides to control weeds is a major problem that limits strawberry production in Alabama.

Soil building crops could prove an economic and conservation plus in Alabama.

control by each herbicide was good, and only 2,4-DB failed to provide late broadleaf weed control. No herbicide treatment provided acceptable season-long control of sicklepod.

The Conservation Reserve Program Could Boost Alabama Agriculture

Interest has been high in participation in the Conservation Reserve Program (CRP) in certain areas of Alabama. However, a ceiling exists that presently limits participation to 25 percent of the eligible cropland. An economic analysis was carried out at the Experiment Station to determine net benefits of higher levels of participation.

Economic benefits associated with the planting of grass and trees as well as the costs of establishment and annual expenditures were determined, with future costs and benefits discounted to 1986



values. Benefits exceeded costs for levels of participation up to 40 percent of eligible cropland. The multiplier effects from the use of CRP payments and expenditures would generate additional income and employment. Soil erosion as well as stream pollution would be reduced and build-up in organic matter in the soil would be a reserve for future use.

Forestry

More efficient utilization of forest resources promises an even brighter future for Alabama's booming forest industry.



Forestry is a billion dollar annual industry in Alabama, and with the opportunity for value added products and more complete utilization of forest resources, the opportunities for growth are excellent. Forestry researchers in the Experiment Station are currently exploring several new structural products that will utilize what was once considered waste wood in Alabama. At the other end of the production cycle, forest herbicide researchers at Auburn have built an international reputation for excellence in weed control in tree nurseries and are currently extending this technology to India and Haiti via large international grants. Despite the emphasis on production, researchers are also keeping an eye on the environment and wise usage of forest resources. A team of Experiment Station researchers is studying the effects of acid rain on the growth of southern pine trees as part of a seven-state study on the detrimental effects of contaminated air and rainfall on forest growth.

Alabama Forests Producing Wood for Composite I-beams

Strong potential for improving the utilization of Alabama's total forest resources involves the development of composite structural I-beams which

can be produced from a wide variety of trees including many hardwoods. It is estimated that as the use of these components grows, approximately 2,500 million square feet of composite panels will be needed annually in the United States for I-beam fabrication. This suggests that the success of the development of composite I-beam building components can have a significant economic impact on Alabama in the production of wood based materials.

Preliminary results from static bending tests indicate that such composite I-beams, fabricated with finger-jointed small cross-section, short stock southern pine lumber as flanges and hardwood composite panels as web materials, are suitable for structural application in light and medium frame construction. Their engineering performance, such as maximum load and deflection criteria, can be equivalent to that of traditional solid lumber. In some cases the developed composite I-beams can be superior because they can be designed to meet specific engineering requirements.

Among the problems in I-beam construction are the dimensional changes in the web materials and the mismatch of shrinkage and swelling coefficients of web and flange materials in composite I-beams, which can result in problems in the serviceability and safety and can subsequently reduce service life. To understand the environmental effects on the strength and durability of wood composite I-beams and to develop techniques for better structural design, full size I-beams and solid-sawn lumber members have been studied under long-term load in an environmentally controlled laboratory. Using the resulting data, mathematical models for predicting the strength, durability, reliability, and service life of composite structures and solid lumber under changing environments were developed.

Flakeboard Production Uses Less Desirable Tree Species

Auburn's development of structural oriented flakeboards for use in housing and other uses permits utilization of several less desirable tree species from Alabama forests. Researchers are using a high percentage of low quality and high density hardwoods, particularly Southern oaks, in combination with southern pine or medium density hardwoods, such as sweetgum and tupelo and yellow poplar. These flakeboards are used in



Development of I-beams, currently in demand from builders, provides more efficient use of Alabama's forest resources.

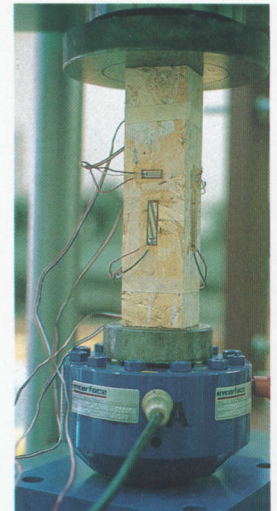
panels for roofing and floor sheathing in housing and as agricultural containers and shelving in industrial warehouses.

Other flakeboards, to be used as siding, concrete forms, and other exterior uses, are being experimentally produced by overlaying structural flakeboards with resin impregnated craft paper and then applying various surface and edge finishes.

Researchers Study Efficiency of Forest Harvest Equipment

A comprehensive study of engineering design and operational characteristics of machines for felling and bunching trees is an ongoing project for forest engineering researchers. Production criteria, including turning radius, wheel torque, tire size, vehicle weight and weight distribution, speed, and acceleration are being examined to determine the effect of design parameters on feller-buncher performance. Performance of these forest harvesting machines is being characterized in terms of mobility, maneuverability, stability, and capacity for cutting and bunching trees.

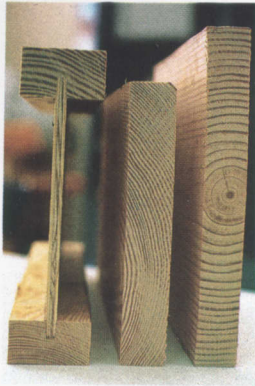
A computer simulation program has been designed and is being used to study feller-buncher design and maneuverability among standing trees. A video-game-like format provides the user a center-steer or crab-steer vehicle to be maneuvered among random or grid spaced trees.



Flakeboard offers potential use for tree species not wanted in pine plantings.

Improving Treatments for Wood-Based Materials

An ongoing research project is concerned with the use of wood treated with chemicals that have been found to enhance both durability and safety. Although these treatments are widely applied commercially and quite effective, interactions with the wood may negatively impact physical and me-



Processing and manufacturing of products from Alabama grown lumber could add value-added products to the State's economy.

chanical properties. Researchers are investigating the nature of the chemical associations, and the concomitant changes in structural characteristics.

Of particular concern is the degradation of roofing panels treated with flame retardant chemicals. Over 6.2 million cubic feet of wood was treated with fire retardant chemicals during 1984 in the United States, and this is increasing every year. Fire retardant chemicals are primarily used in engineered roof systems on multi-family dwellings, as required by applicable building codes.

While effective in the inhibition of combustion, the presence of fire-retardants has been found to reduce mechanical properties, and therefore engineering designs must be altered. Ultimately, it may be possible to change the processing of treated wood, but before choices can be made in this regard, there must be a fundamental understanding of the chemical and physical changes that are occurring.

Infrared spectroscopy, nuclear magnetic resonance spectroscopy, and scanning electron microscopy are being used to determine the effects of flame retardant chemicals. A complete understanding of chemical and molecular changes between the wood and chemical treatment is vital so that improvements can be made in fire retardant treatments without sacrificing either chemical efficiency or structural strength of the treated wood.

More efficient use of forest harvesting machinery is being studied in 3-D video.



High Quality Lumber Developed for Construction

Several parallel laminated veneer lumber products for use in heavy construction are currently under development. Such products fulfill special structural needs, such as flanges of composite I-beams, highly stressed tension members of roof trusses, and as high stressed structural members of furniture. Parallel laminated veneer lumber is expected to have higher quality and strength than lumber of the same size because with this process the strength reducing defects, particularly knots, are redistributed. The product is more expensive to produce than ordinary lumber, but has subsequently higher retail value.

Tree Strength Data Helping in Harvest Machinery Design

Developing more efficient and economical harvesting equipment is vital to continued growth of Alabama's forest industry. Information from research on the engineering properties of southern pine trees is being used to better design machines that handle trees in harvest operations.

Data taken from 25 whole trees were used to predict bending stiffness, center of mass, and mass moment of inertia of loblolly pine trees in Alabama. A finite element method approach was used to determine an effective modulus of elasticity for whole tree stems. Stem taper equations were used to predict center of mass and mass moment of inertia. Predicted values compared favorably with the measured data.

Forest Harvesting Systems to be Studied in 3-D Video

Experiment Station researchers are developing a perspective-view (three dimensional) interactive video simulation of forest harvest systems to be used to provide information to improve engineering design of harvesting equipment. Previously collected data are being employed in a program to display forest harvest study plots in 3-D computer animation. Initial work is underway for interactive simulation of feller-bunchers, skidders, and forwarders. Machine operation on the study plots will eventually be simulated.



Director Frobish (center) is shown presenting Director's Research Awards to Dr. Jim Sartin (left) and Dr. Elroy Curl (right).

Honors and Recognitions

Director's Research Award

The highest honor a researcher can receive from the Alabama Agricultural Experiment Station is the Director's Research Award. Established in 1981, this award recognizes exceptional contributions to the mission of the Experiment Station over the individual's Auburn career. Two awards are given each year, one for Professors and one for Assistant or Associate Professors. The winners are selected from among nominees proposed by individual departments within the five schools and colleges that conduct research under the auspices of the Experiment Station.

Winners for 1987 were Elroy A. Curl, Professor in the Department of Plant Pathology in the College of Agriculture, and James L. Sartin, Associate Professor in the Department of Animal Health Research in the College of Veterinary Medicine. Their records of research accomplishments truly exemplify the mission of the Alabama Agricultural Experiment Station and the philosophy of the Land-Grant University system.

Curl is a leader and pioneer in soil-microbial ecology research relating to plant diseases. He began his work at Auburn in 1954, and in the early part of his career focused on the need to understand the relationship between the ecology of the soil rhizosphere and complex factors related to crop damaging plant diseases. Curl is considered one of the world's foremost authorities on methods of microbial research and is the coauthor of a

highly regarded book on the subject, "The Rhizosphere."

Sartin's research is providing insights into the hormonal releasing factors and hypothalamic-pituitary interactions in the control of growth, lactation, and metabolic activity. Though basic and behind the scenes by nature, Sartin's work is providing the foundation for more applied projects that have a significant impact on Alabama's livestock industry.

State and National Recognitions

Listed below are some of the recognitions received by research faculty from various agencies and organizations during 1987.

Bryan Truelove—Distinguished Service Award from the Southern Weed Science Society and appointed Editor-in-Chief of the Weed Science Society of America.

John D. Weete—Received International Scientific Exchange Award from the Natural Sciences and Engineering Research Council of Canada to spend 2 months conducting research in the Department of Biochemistry at the University of Ottawa.

Wanzer Drane—U.S. National Academy of Science Exchange with the Romanian Academy, Bucharest.

Carol L. Warfield—Alumni Award of Merit from the University of Illinois-Urbana.

B. Lewis Slaten—1987 ASTM Committee D-13 on Textiles Certificate of Appreciation Award.

J.A. Renden—Section Editor (Physiology and Reproduction) Poultry Science Association and a member of CSRS Review team for Department of Poultry Science, Ohio State University.

R.N. Brewer—Alabama Poultry and Egg Association Presidential Award.

John L. Adrian —Elected to Board of Directors of the Food Distribution Research Society.

L. Conner Bailey—Elected Co-Chairman, International Development Research Group, Rural Sociological Society.

Howard A. Clonts—Selected to serve as Chairman of the Program Review for the Gulf and South Atlantic Southeast Area Monitoring and Assessment Program by the National Marine Fisheries Service. Received commendation from National Recreation and Park Association (NRPA) for assistance in deliberations of eight NRPA/President's Commission on American Outdoor work groups.

John E. Dunkelberger—Elected Chairman of the Nominating Committee and member of the Executive Committee of the Mid-South Sociological Association.

William E. Hardy—Received the Outstanding Achievement Award for the best theoretical/empirical research paper at the annual meeting of the Southeast Decision Sciences Institute.

L. Upton Hatch—Invited to present paper in "Role of Public Policy in Commercial Development of Biotechnology" at the Brookings Institute Policy Development Seminar in Washington, D.C.

Joseph J. Molnar—Appointed Chairman of the Rural Sociological Society Liaison Committee to the American Association for the Advancement of Science.

Rodrigo Rodriguez-Kabana—President-elect, Society of Nematology; Senior Editor, Plant Disease; Associate Editor, Plant and Soil; Associate Editor, Annals of Applied Nematology.

Barry J. Jacobsen—Member, Department Heads, Chemical Control, and Post-Harvest Pathology Committee of American Phytopathological Society

Robert T. Gudauskas—Member of Public Responsibilities Committee of American Phytopathological Society, Member, Executive Committee of Southern Corn Improvement Conference; Member, Board of Trustees, Alabama Academy of Science.

Jacqueline Mullen—Member, Diagnosticians and Diseases of Ornamental Plants and Turfgrasses Committees of American Phytopathological Society.

Paul A. Backman—Co-editor, Soybean Disease Compendium; Chairman SRIEG-29 Committee on Pesticide Application Technology; Chemical Control Committee APS; Associate Editor Peanut Science.

Gareth Morgan-Jones—Chairman, Placement Committee, Mycological Society of America; Member, Mycology Committee of the American Phytopathological Society.

Urban L. Diener—Member, Mycotoxicology Committee, International Society of Plant Pathologists.

Financial Report

Alabama Agricultural Experiment Station
Report of Revenues for the Fiscal Year Ending September 30, 1987

<u>Appropriated Funds</u>		\$12,878,531	49.9%
State			
Federal		3,715,088	14.4%
<u>Contracts and Grants</u>	1,756,664		
Federal			
State	680,428		
Private	<u>2,326,296</u>	4,763,388	18.4%
<u>Auxiliary Revenues</u>	3,365,916		
Sale of research products			
Diagnostic services and fees	294,760		
Interest and royalties	218,907		
Indirect and other cost recoveries	<u>586,313</u>	<u>4,465,896</u>	<u>17.3%</u>
Total Revenues		<u>\$25,822,903</u>	<u>100.0%</u>

