

# Annual Report 1979

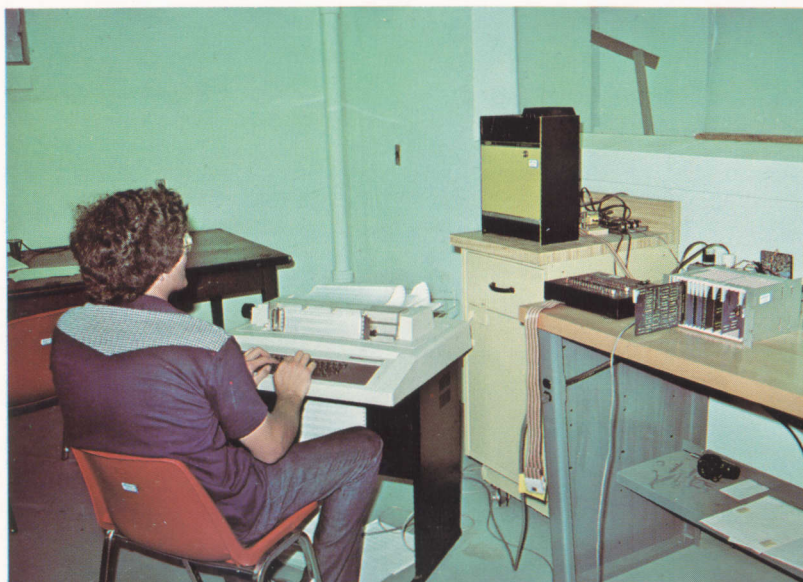


Agricultural Experiment Station

Auburn University



TOP LEFT: The wild Peruvian tomato is being used in Auburn breeding work to provide disease and insect resistance. TOP RIGHT: Nutritional studies seek answers to health problems of specific age groups. CENTER: Varying the cycles of light and darkness was found to affect egg production. BOTTOM LEFT: Auburn-developed laboratory method provides accurate measure of grain moisture content during loading or unloading. BOTTOM RIGHT: AU Lotan, new Auburn sericea variety, produces forage with low tannin and high feeding value.



## Director's Comments



I am pleased to convey in this report a summary of the important research and development program of the Alabama Agricultural Experiment Station during 1979. The administrators, scientists, and staff of this Station have a great sense of accomplishment, but they also share a realization that there is much more that needs to be done.

The people of Alabama have every reason to be confident that the tax dollars provided this unit of higher education by the Alabama Legislature for use in conducting the programs of research in the food and agricultural sciences (including forestry) are used in the best interest of all producers and consumers of food and fiber, not just farmers. In fact, studies during the years have shown that investments in agricultural research by State Agricultural Experiment Stations have, through application by commercial agriculture of the new technology developed by research, been responsible for a rate of return—interest if you will—of approximately 50 percent annually. Surely this is an outstanding return even in a period when interest rates on borrowed money may exceed 15 percent. However, just as 15 percent is excessive on borrowed money (indicating an inadequate amount of money available for borrowing), 50 percent is an excessive rate of return on the investment in food and agricultural research (indicating not enough money is being invested in this research to derive the greatest benefit to the investors).

Alabama agriculture is a science and technology-based system of land and resource use. Future progress in agriculture, more than ever before,

will depend on the development of a steady stream of new knowledge and understanding of the biological, physical, mechanical, economic, and social systems of production, transportation, processing, marketing, and consumption of products of the farm and forest. Innovations and modifications can make the system function more effectively for the betterment of all the people.

During the forties and fifties, our scientists were developing and farmers were taking advantage of technologies that enabled them to benefit from an abundant supply of cheap energy and industrial labor. Industrial labor gradually became more and more expensive, but the big change came in the seventies when a concern for the quality of environment became overpowering, especially by those with little understanding of the biological system. During the past 10 years, agricultural scientists have had to spend an exorbitant amount of time in defensive research—proving again in new words what was already known, and frequently to government officials (Environmental Protection Agency and Occupational Safety and Health Administration) whose training was inadequate for them to understand. Industries have had to devote more resources to defense of products and equipment already in the market than in developing new and improved products.

Now we are faced with even more formative challenges in addition to the

already existing obstacles. We must find ways of (1) producing more while using less energy, (2) developing energy substitutes for petroleum and petro-chemicals, and (3) utilizing what we produce more efficiently.

Agriculture in its broadest sense—the wise management of our land and waters for producing food, fiber, forest products, wildlife, and outdoor recreation—is the largest industry in Alabama and the Nation. The economy of this State, Nation, and the world depends on the viability of agriculture. Agriculture's future rests on how well its publicly-supported research program is financed and managed. The administrators of the research program of the Alabama Agricultural Experiment Station pledge to the people of this State sound management of an innovative research program. It is the responsibility of the people of this state to provide the support needed to maintain a research base adequate to meet the continuing challenge of the biological world and the new challenges of an energy shortage.

This report is presented to provide an overview of the kind of research in which the Alabama Agricultural Experiment Station is engaged. As Director, I would welcome an opportunity to explain any aspects of the program of the AES and what it can do for the people of Alabama.

*R. Dennis Rouse  
Dean and Director*



Completion of new buildings at the Solon Dixon Forestry Education Center, near Andalusia, provides ideal facilities for forestry and wild-life teaching and research. Among the new buildings are the dining hall and dormitory (left photo) and the staff house, Charles Dixon Auditorium, and dormitories (below).



## Highlighting Work of Research Operations



LEFT: The 200 acres of old pecan trees at the Turnipseed-Ikenberry Place are being used in studies on restoring old, neglected pecan orchards to production. ABOVE: Poultry research capabilities were improved by addition of a modern isotope lab at the Poultry Annex.



Alabama's important peanut industry will be served by the new Foundation Peanut Seed Facility at the Wiregrass Substation.



A new cage house and broiler house added to the Poultry Research Unit at the Main Campus make possible expanded research.

Development of facilities at the new Solon Dixon Forestry Education Center, near Andalusia, was a major thrust of 1979 work by the Department of Research Operations. Seven new buildings were completed, the old Dixon home was renovated, and walks, driveways, and parking areas were constructed, making the new Center ready for use in forestry and wildlife teaching and research programs.

The new facility, which includes some 3,000 acres of timberland, was made possible by gifts from Dr. and Mrs. Solon Dixon and Mrs. Thelma Dixon, all of Andalusia, to Auburn University. Facilities at the Center include dormitories, dining hall, and a classroom-auditorium for students, housing for the teaching faculty while conducting summer courses, superintendent's home, machinery shed, and the old Dixon home, which serves as library and museum. The forest land provides the basic natural resources needed for both teaching and research in forestry and wildlife. Nearness of the Center to forest lands managed by the Federal government and also private corporation lands adds to the uniqueness of the facility.

Other facility improvements during the year included both new construction and renovation and upgrading of existing buildings at the main campus. These additions should significantly improve the capability for research in certain fields by the Agricultural Experiment Station.

Poultry science facilities were upgraded by adding a cage house and broiler house at the new Poultry Research Unit and renovation of the Poultry Annex. The renovation added a modern isotope lab and pleasant offices for poultry physiology research at the Annex.

Completion of the Swine Physiology Lab Annex and renovation of the Meats Laboratory will make possible expanded meat animal research by the Department of Animal and Dairy Sciences. The annex to the Physiology Lab will serve as a support facility for the Physiology Lab and provide holding space for animals during pre-operative and post-operative periods.

Working and storage areas of the Meats Laboratory were modernized and additional space was provided. A sales room was added, which will provide an outlet for all saleable products from research.

A livestock breeding barn built for use of the Department of Animal Health represents an important addition to that department's research facilities.

Alabama's peanut producing region will be served by the new Foundation Peanut Seed Facility that was completed in 1979. Located at the Wiregrass Substation, in the heart of the peanut growing area, at Headland, the facility will assure that peanut growers can get top quality seed, a big need for most profitable production. The new facility will be operated by the Alabama Crop Improvement Association.

Continued improvements to the Turnipseed-Ikenberry Place, a 1,026-acre unit that was donated to the Agricultural Experiment Station in 1976, have improved the utility of this area for pecan research. Although the majority of acreage is in timber, there are about 200 acres of old pecan trees that represent a valuable resource for studying methods and economics of restoring old, neglected pecan orchards to production. Current research is on insect and disease control and problems associated with alternate-year production.



ABOVE: New sales room serves as an outlet for saleable research products. BOTTOM: Annex to Swine Physiology Lab provides holding space during pre- and post-operative periods.





## ANIMAL AND DAIRY SCIENCES

### Production of Fuels and Animal Feed from Biomass

In research on production of liquid fuels by fermentation of sugars in agronomic crops and wood, efficient conversion of wood sugar to alcohol has been achieved with an organism isolated from decomposing wood. In addition to alcohol for fuel, the organism also produces protein which has value as animal feed. The U.S. Department of Energy is supporting the fuels project, which is cooperatively conducted by the Department of Animal and Dairy Sciences and the Department of Chemical Engineering. The Grants and Contracts Office of Auburn University is currently studying the possibility of patenting the microorganism used in the Auburn fuels project.

### Relationship of Diet to Cholesterol

Studies in our biochemistry laboratories indicated that rats fed a ration high in soybean oil with 0.5 percent cholesterol deposited more fat and cholesterol in the heart than rats fed a high lard diet containing 0.5 percent cholesterol. Pretreatment of young, weanling rats with 0.5 percent cholesterol increased the tolerance to cholesterol after 5 weeks. Since the normal human diet supplies about one-third and synthesis in the body supplies about two-thirds of the daily cholesterol, caution should be exercised in recommending radical alterations of the diet for the general population.

### Exotic Crosses Have Merit

There was an average difference of approximately 42 pounds per calf at weaning in favor of the Limousin-sired calves out of Hereford and Hereford x Angus-Hereford cows when compared to calves out of similar cows sired by Hereford bulls. This difference was only 11 pounds when the calves were out of Charolais x Hereford or Charolais x Angus cows. Finishing the crossbred steers on a grazing and feeding system took 109 days longer than finishing in the feedlot. There were no major differences in carcass traits.

### Efficiency of Lagoon System

During 46 months of bi-monthly monitoring of wastewater quality in a two-stage lagoon system, the average overall reduction of pollutant concentrations was greater than 90 percent for 6 of 11 pollutants monitored. Using recycled wastewater from the secondary lagoon for cleaning a free stall barn did not affect the waste treatment efficiency of the lagoon system.

### Swine Breeding

Interactions between genotype and pen density (8 or 16 pigs per pen) were found in Auburn swine research. Interactions were noted for average daily gain and lean tissue growth rate, which resulted in significant changes in rankings of sire groups for the two pen densities. This has major application to progeny tests, suggesting that progeny tests should be undertaken only in pen densities under which the future progeny will be grown.

Using recycled wastewater from the secondary lagoon for cleaning a free stall barn did not affect this lagoon system's efficiency.

### Estrus Synchronizing Agent for Swine

Regumate, an estrus synchronizing agent for swine, was studied in our physiology laboratories. All treated gilts returned to estrus 4 to 6 days after withdrawal of the compound. No harmful effects were noted for ovulation rate, conception rate, presence of cystic follicles, or number of abnormal pigs. The results suggest that the product is safe and could be recommended for use following FDA approval.

Limousin-sired calves from English cross cows grew faster than calves from similar cows sired by Hereford bulls.



# AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

## Estate Planning a Big Need

Lack of adequate estate planning was apparent in findings of a survey of 204 Alabama farmers. Results indicated 39 percent held their property in joint ownership with right of survivorship with the wife. These farmers were apparently using this method of ownership in lieu of a will since less than 40 percent of them had prepared wills. Ten percent of the respondents operated their farms as partnerships. Less than half of these had drafted wills and only two had used the partnership arrangement as an estate planning tool.

The surveyed farmers suffered from an almost total lack of awareness of estate planning. Only 5 percent had attended workshops on estate planning and only 12 percent had read any estate planning publications. Also, only a small proportion had been reached through extension communications.

## Farm Land Market and Influences

Agriculture represents the major market for rural land in the Limestone Soil Region of Alabama. An Auburn survey found that nearly half of purchases (47 percent) were for farming and/or home and farming. Nonagricultural influences also were important, with home and speculation being reasons for purchase in 18 and 21 percent of the transactions, respectively.

Sixty-six percent of the tracts sold were owned for 10 years or less, while 54 percent were owned for 5 years or less. Almost half of the purchases were for property adjacent to existing holdings, indicating the importance of expanding farm size.

Significant factors in explaining the variation in per acre value of rural property were location relative to cities of 25,000 or more population, value of residential improvements, presence of paved road frontage, presence of community water lines, and tract size.

## Marketing of Soybeans

Personal interviews with managers of terminal elevators identified these factors used in setting spot prices: (1) local, domestic, and export marketings; (2) cost of freight from country to terminal elevators; (3) the supply of soybeans at country elevators; and (4) the predicted value of soybeans for resale as processed products. In the 1977 marketing year, 23 percent of the soybeans were sold on the spot market, 37 percent were sold by different pricing agreements, and 40 percent by forward contracting.

## Legal Knowledge of Farmers

An interview with 202 randomly selected full-time farmers in five predominately agricultural areas concerning their knowledge about legal rights and responsibilities indicated a need for more legal information in most of the 13 subject areas covered. Generally, they were most knowledgeable about mineral rights and negligence. Least knowledge was indicated in the areas of offers, employees, and estate planning.

Little difference in knowledge was found by age level or farm size classification. As educational level and income increased, however, there was an increase in correct responses.

## Christmas Tree Use

Most Alabamians have a Christmas tree in their home during the holiday season, but more than half of these are artificial trees. Returns from a mailed survey in nearly all Alabama counties indicated that 85 percent of residents used a Christmas tree. Of the users, 60 percent had artificial trees, 25 percent purchased cut trees, and 15 percent cut their own trees at no cost. Artificial tree users were generally satisfied with their trees and continued to use them for several years.

The most popular species of cut trees were eastern red cedar, spruce, and scotch pine. About two-thirds of the purchased trees were between 6 and 7 feet in height.



Wide price ranges for broiler parts were found in a study in Alabama grocery stores.

## Broiler Prices Vary

Variability characterized the advertised price of fryer and fryer parts among eight Alabama grocery stores during the 1975-77 period. The widest range was in prices for drumsticks for which there was a 92¢ per pound difference between high and low. For breasts and thighs, the ranges were 90¢ and 62¢ per pound, respectively. The smallest range was for whole fryers, 33¢ per pound.

The highest weighted average advertised price was for thighs at 84.4¢ per pound. In descending order, prices per pound for other forms of fryers were: drumsticks, 77.7¢; breasts, 76.7¢; whole split fryers, 58.1¢; and whole fryers, 54.7¢. Variability in advertised prices was not found to be related to size of city in which a store was located.

## Price Discovery and Marketing Methods

Peanut and soybean growers have the greatest number of market outlets available, while cotton growers use the smallest number of selling points. Half the soybean and one-third of the corn and peanut growers were found to utilize cooperatives in marketing their crops. Less than half the farmers reported using any form of storage. Those who forward contracted part or all of their production received higher than average prices.

Peanut and soybean growers have more available markets than producers of other commodities.



Soybean growers with large acreages utilized forward contracts and storage more frequently, were willing to travel greater distances to market, and obtained higher average prices than growers with small acreages. Input costs and expected cash prices at harvest were dominant factors in all operators' production planning decisions.

#### **Economic Development Supported**

Economic development and the attitudes of leaders and household respondents were studied in an eight-county area of Alabama's section of the Tennessee-Tombigbee Waterway. Major findings indicate a general support for rural industrialization tempered by broad-based reservations about environmental deterioration and associated health risks.

A leader survey identified several problematic organizational issues involving the rural development committee. Black leaders expressed greater concern over employment issues, while white leaders emphasized the fiscal impacts of industrial growth. Most leaders expected the waterway to have positive effects on their county.

## **AGRICULTURAL ENGINEERING**

#### **Low Energy Pond Aeration**

Daytime stirring — instead of nighttime splashing, spraying, or bubbling — can satisfy a fish pond's aeration needs with only a low electric power input. Two paddlewheels, designed at Auburn, require only 65 watts each to keep water moving in a 1¼-acre pond. As the water moves it mixes oxygen-rich surface waters with the oxygen-poor water at a lower level. More importantly, the daytime stirring evens out water temperature so that as night temperatures cool the water surface the top water sinks to the pond bottom. This increases the water's oxygen content at that level.

#### **Farm Machinery Reliability Examined**

A 5-year study to examine farm machinery reliability is currently in progress. Its major purpose is to determine the frequency, duration, and probable cause of farm machinery breakdowns. These data will be correlated according to total hours of use or acres covered, soil type, farm size, and crops grown. Results from this study will be useful to individual farmers as they plan for effective and efficient machinery utilization.

#### **Producing Cotton with Minimum Energy**

A minimum tillage, controlled traffic system for double-cropping of cotton and reseeded crimson clover offers good yields and energy savings. In the fall of 1975, crimson clover was seeded and has reseeded itself each year since. Each spring after the clover seed are mature (May 1-May 20) cotton is planted in the



clover with a no-till type planter. The clover residue is allowed to remain on the surface as a mulch until cultivation is necessary for control of grass and weeds. Four-year results indicate that cotton can be produced in a crimson clover stubble without loss of yields. Not only does the no-till system reduce tillage requirements, but the clover furnishes nitrogen to replace commercial nitrogen fertilizer for an additional petroleum saving.

#### **Animal Waste Disposal and Utilization**

Evaluation of multi-cell anaerobic lagoon systems employing recycled wastewater for flushing livestock production facilities showed more problems with swine than with dairy. Findings of a nearly complete laboratory and field scale study for swine waste included: (1) Salt buildup in lagoon supernatant is a serious problem for swine waste, but not for dairy waste. (2) Lagoon supernatant removal will be required for Southeastern climates at frequent intervals (2 to 4 months). (3) Pathogen survival is not a problem provided lagoon detention time is greater than 32 days. (4) Lagoon life (first cell) is approximately 6 years for swine waste loaded at ASAE recommended rates (approximately 8 years for *settled* dairy waste loaded at ASAE rates).

The major problem for salt buildup with swine waste was in the effects this salt has on land application and pumping equipment. The level of salts did not interfere with microbial lagoon performance as mass balances of solids showed no inhibitory effects. The major limitation will be in land application because high salt concentration can seriously affect soil texture and crop performance. Major problems in pumping equipment is caused by salt accumulation in suction lines and on pump impellers. Cleaning of the pumps every 2-3 months and replacement of suction pipe each year is required. No problems of this nature were found with dairy waste.

Drip-irrigated pecan trees made much higher yields than non-irrigated or sprinkler-irrigated trees of the Cape Fear variety.

A new project just getting underway is investigating methods of using agricultural wastes to advantage. Methods being tried include (1) energy production through anaerobic digestion for on-farm application, (2) single cell protein production through the growth of microalgae that can be used as a feed ingredient, and (3) direct refeeding of the screened flushed waste from animal production units.

#### **Special Tillage Problems Studied**

Some of the tillage management problems that farmers face with Coastal Plains and Black Belt soils of Alabama are being attacked in joint studies by the Agricultural Experiment Station, USDA Soil and Water Research Unit, and the National Tillage Machinery Laboratory.

Many Coastal Plains soils have sandy topsoils overlaid with clayey subsoils, and these tend to be droughty and compact easily. Techniques are being developed to predict and determine if a soil's available moisture for crop use may be increased and its compactibility decreased by mixing some subsoil with the topsoil. Methods of creating ideal mixtures are being explored.

For the Black Belt soils—those that expand and contract during wetting and drying—the aim is tillage machinery and management systems that utilize the soils' ability to 'buckshot' to develop a seedbed and to minimize soil erosion. The concept is to produce and maintain a small bed or wide ridge in the fall so the bed tops would 'buckshot' and settle during the winter. Row crops would be planted on the permanent bed tops, which would aid surface drainage, control runoff, and reduce erosion. Earlier planting would be permitted and less tillage energy would be expended.



### Accuracy in Measuring Grain Moisture

An automated system of determining grain moisture content is being developed at Auburn as an aid in marketing. An accurate measurement of the moisture is needed at selling time to arrive at a fair price for the actual dry material being sold.

The present method of measuring moisture content is pulling a sample from various locations in the grain and taking moisture content readings with a moisture meter. In contrast, the new Auburn system will automatically monitor moisture content as grain is being loaded or unloaded. The system is composed of a moisture meter, a microprocessor, and a DEC-Writer to record the moisture readings on paper. Increasing the number of readings gives a better idea of moisture content and offers the buyer and seller a more accurate measure of actual dry material that is being marketed.

### Drip Irrigation Aids Pecan Production

Pecan trees in the sixth growing season showed a positive response to irrigation. The best yields for the Cape Fear variety, 1,360 pounds per acre, were obtained from a drip irrigation treatment that was turned on and off by a soil moisture meter. By comparison, the non-irrigated trees produced 430 pounds per acre. Sprinkler irrigation produced the largest trees, but yield was only 770 pounds per acre. Sprinkler results indicate that too much vegetation and delayed flower formation will reduce production. (Cooperative project with Department of Horticulture.)

No-till cotton following crimson clover produced good yields with low energy outlay.



## AGRONOMY AND SOILS

### Deep Incorporated Lime Better

Since most Alabama soils are acid, crop yields generally can be improved by applying lime to the soil surface. But incorporating lime into the subsoil gives even more benefit. Deep lime incorporation leads to increases in depth of rooting, soil water extraction, and plant heights, thereby boosting crop yields. In cotton studies, yield improvements from lime increased with depth of incorporation to 12 inches. Incorporating to a depth of 18 inches did not improve yields over 12-inch incorporation.

Marketable sweet potato yields increased and cull yields decreased as subsoil pH increased. Marketable yields per acre varied from 7,380 pounds at 4.7 subsoil pH to 27,580 pounds at 6.0 subsoil pH.

In other lime research, lime slurry proved to be no better than dry lime for use on acid soils. This finding was in contrast to claims that rates of the lime slurry lower than for dry lime would be adequate. Instead, the lower rate used on farmers' fields failed to raise pH to the desired level, and peanut yields were lower than when the recommended rate of dry lime was used. The lime slurry contains only 50 percent finely ground limestone (almost half is water), which explains why the full rate would be needed to adequately neutralize acid soils.

### Improving Weed Control

Potential improvements in crop weed control found in Auburn research concern antidote additives that make effective herbicides safe to use, a herbicide combination that boosts yield while controlling cocklebur, and planting in narrow rows to take advantage of crop competitiveness against weeds.

Two of the ethoxylated aliphatic chemicals tried as antidotes improved safety of metribuzin (Lexone, Sencor), a herbicide that is highly effective against sicklepod but which often causes soybean damage on coarse textured soils low in organic matter. Results also were good when linseed oil or soybean oil was substituted for part of the antidote chemical before adding to formulated metribuzin. Sicklepod control was excellent on four sandy type soils.

Cocklebur, another tough soybean weed pest, may be controlled by a new herbicide, benazolin, at rates as low as 2 ounces per acre, results of another test indicate. Injury to soybeans has been slight to moderate from benazolin alone, but injury was reduced and yield increased by using a tank mix of benazolin with bentazon (Basagran). A yield increase from the tank mix, amounting to 7 bushels per acre, was obtained in a study in which weeds were not a variable. Thus, the chemical combination shows the potential for increasing soybean yield as well as providing excellent cocklebur control.

Weed suppression of narrow-row peanuts and soybeans indicated potential weed control from close row spacing. Soybeans in 10-inch rows had less weed trouble than beans in 30-inch rows at all planting dates tried. Narrow-row yields were equal to 30-inch rows from early May plantings, and higher if planted in late June. Peanuts grown in 12-inch rows made 10-20 percent more unshelled peanuts than when 36-inch row width was used.

### New Sericea Released

AU Lotan, an improved variety of sericea lespedeza just released by the Agricultural Experiment Station, is a true low tannin variety that has high feeding value.

With 50 percent less tannin, forage of AU Lotan is higher in digestible dry matter, which means it has higher feeding value than available sericea varieties. The new variety averaged 15 percent crude protein in three hay cuttings. Hay yield is comparable to older, high tannin sericeas. Seed of AU Lotan should be available in limited quantities in 1981.

### Subsoiling Harmful to Some Soils

Even if it increases crop yields, subsoiling may be undesirable on some soils because of long term detrimental results. For example, Auburn research found that compaction problems may be increased by subsoiling, or by other tillage that mixes topsoil and subsoil. Compactibility, density, and soil strength measurements showed that in the season following subsoiling, mixtures of topsoil and subsoil in subsoil channels compacted to densities greater than those of the original subsoil. Continued subsoiling of certain soils will produce thicker, denser, and stronger hard pans than those that develop in conventionally-tilled soils. This increases energy requirements for tillage and may eventually reduce crop yields. Generally, the mixing of a sandy topsoil with a clay or clay loam subsoil is undesirable. If topsoil and subsoil are of similar texture, no harm will be done.



Mixtures of topsoil and subsoil in the 1- and 2-year-old channels (left) recompacted to higher densities than those of the original soil.

### Planting Too Deep Cuts Soybean Stand

Planting depth of 1½ inches gave the best soybean stand — 79-95 percent emergence — in all moisture conditions when good quality planting seed were used. With seed planted 2½ inches deep, emergence went as low as 49 percent. When there was a 7- to 15-day dry period



Postemergence application of ethofumesate, a herbicide labeled for use in sugar beets, showed promise of controlling annual bluegrass in golf greens without damaging sod.

after planting, the deepest depth was as good as a shallow ( $\frac{3}{4}$ -inch) depth. With good moisture conditions, however, the  $\frac{3}{4}$ -inch depth was better than the  $2\frac{1}{2}$ -inch depth, but still not as good as the  $1\frac{1}{2}$ -inch depth.

#### Corn-Soybeans vs. Corn-Wheat-Soybeans

Experiments at six locations across Alabama showed advantages of corn-wheat-soybean rotations over corn-soybean rotations. Averages of the best 7 of 11 test years at each location show that wheat averaged 36 bushels per acre without any reduction in corn and soybeans. In fact, the rotation including wheat averaged 3 bushels more corn (97 bushels) and the same yield of soybeans (36 bushels) as the rotation without wheat. Thus, the 36 bushels of wheat represent an additional return to land. Highest yields were produced at the Sand Mountain Substation where yield averages were 128 bushels corn, 43 bushels wheat, and 37 bushels soybeans. At all locations, corn received 120 pounds and wheat 80 pounds of nitrogen per acre. All crops received adequate P and K each year.

#### Pasture, Hay Crops Get Attention

Grass tetany, a troublesome disorder that hits lactating cattle grazing grass with low magnesium content, is less likely on fescue pastures. In tests on four Alabama soils, fescue forage was found to be higher in magnesium content than orchardgrass or phalaris grass.

The new bermudagrass, Tifton 44, was found to have higher forage digestibility than Coastal or Alicia varieties, giving it the potential for better livestock gains. Tifton 44 is cold hardy and has yielded better than any other bermudagrass variety in northern Alabama. Yields elsewhere in the State have equalled or exceeded those of Coastal.

#### Controlling Annual Bluegrass on Golf Courses

A herbicide currently labeled for use in sugar beets gave good postemergence control of annual bluegrass on golf greens. November and January application of ethofumesate (Nortron) controlled annual

bluegrass, the worst weed pest on golf courses, without damaging perennial ryegrass. This is the first selective postemergence control found during 10 years of screening that offers hope of solving the problem of unsightly seed heads, mottling on the green, and an irregular putting surface caused by annual bluegrass.

#### Nitrification Inhibitors Not Effective

Chemicals such as etridiazol (Dwell) and nitrapyrin (N-Serve) that block the conversion of ammonium to nitrate by soil bacteria failed to increase yield in 1979 tests with cotton and corn. The anticipated advantage of blocking this conversion process is that while nitrogen remains in the ammonium form it is not subject to leaching or denitrification loss, as is nitrate nitrogen. Since plants utilize ammonium as well as nitrate, the total amount of nitrogen available to the crop may be increased.

Although both etridiazol and nitrapyrin delayed conversion of ammonium to nitrate during the 2-month period after fertilizer application, total available nitrogen was not increased. Good yields were obtained, averaging 2,750 pounds per acre of seed cotton and 152 bushels per acre of corn, without significant effects from etridiazol or nitrapyrin.

#### Rejuvenating Depleted Soils

Plots at five locations that had not been fertilized or limed since 1928 while continuously cropped to cotton, corn, and soybeans were fertilized and limed, to soil test recommendations, for the first time in 1978. Yields were low in 1978 because of drought, but production in 1979 was good: 38 bushels of soybeans per acre on soils fertilized throughout the 50-year period and 37 bushels for the soils fertilized in 1978 and 1979 after 50 years without fertilizer. Plots receiving no fertilizer or lime for 50 years averaged 17 bushels in 1979.

#### Slit Planting Looks Good

A new tillage and planting system, "slit planting," shows promise for use in soil, water, and energy-conserving cropping practices. In this system, a vertical slit cut through compacted soil layers, such

as tillage pans, provides a channel for the downward growth of plant roots. In a comparison of soybeans grown on a coastal plains soil without a slit and with a 15-inch deep slit, soybeans planted over the slit produced 27 bushels per acre compared with 15 bushels without the slit. Soybean taproots reached the bottom of the slit in 1 week and roots proliferated throughout the subsoil. Roots of soybeans grown on soil without the slit were severely restricted by the compacted soil layer.

#### Alfalfa Furnishes N for Cotton

Cotton following a 4-year stand of alfalfa required no commercial nitrogen applications. In fact, adding N fertilizer reduced cotton yield. Seed cotton yield was 3,136 pounds per acre without N fertilization, as compared with 3,055, 2,778, and 2,548 pounds, respectively, from N rates of 30, 60, and 90 pounds. The alfalfa was plowed under during the winter prior to planting cotton on April 20, 1979.

In a nearby experiment involving rates of nitrogen on cotton that did not follow alfalfa, seed cotton yields were 2,048, 2,922, 2,899, and 2,416 pounds per acre, respectively, from N rates of 0, 30, 60, and 90 pounds per acre.

## ANIMAL HEALTH RESEARCH

#### Animal Health Research Expanded

New research with food animals is seeking solutions to problems of bovine leukemia, swine enteritis, and reproductive diseases and respiratory diseases of cattle. Greater emphasis is being placed on basic studies pertaining to humoral and cellular immune responses of newborn animals to various disease-producing organisms and the development of possible means of enhancing resistance. Considerable effort is being expended to improve the diagnosis and treatment of intestinal parasitisms in cattle.

Approximately 120 female calves born to brucellosis-infected dams are being studied to determine if dam to offspring is an important means of transmission of brucellosis. Four opossums and one raccoon trapped on premises where infected cows were pastured were found to be infected with brucellosis.



Bovine leukemia, swine enteritis, and reproductive diseases are getting emphasis in research on health of food animals.

# BOTANY, PLANT PATHOLOGY, AND MICROBIOLOGY

## Detecting Peanut and Soybean Diseases

Peanut and soybean diseases as well as fertility problems elicit characteristic symptoms on plants affected. In conjunction with ongoing tests for peanut leaf-spot, white mold, and nematode control, aerial infrared photography has been employed to provide rapid diagnosis of the extent and severity of these problems. In photographs from such infrared sensing, healthy peanut plots appear as a continuous deep red color. Plots with peanut leafspot on the increase appear as progressively darker and discontinuous in coloration, while plots with white mold or nematodes photograph as black zones indicative of plant death. Fertility problems show up in infrared scanning as white areas that coincide with exposure of soil between rows of peanuts which fail to overlap. The infrared method when employed by qualified consultants could become a valuable diagnostic tool for problems and control strategies in peanuts and other Alabama crops.

Serum-specific microscopy is being tried for detection of major viral diseases of soybeans. During late 1979, when symptoms of viral infection were observed in plantings throughout the State, this system identified soybean mosaic virus in plants from two locations. This assay method, as its name implies, couples the specificity of serological detection with the visual reinforcement of electron microscopy.

## Seed Treatment for Nematode Control

Something new in nematode control treatment, treating planting seed with a nematicide, is showing promise in Auburn research. Applying a nematicide treatment with planting seed is possible using an Auburn-developed technique for introducing concentrations of the water-soluble nematicide oxamyl into crop seeds.

Oxamyl-treated and untreated seed of bush bean, watermelon, soybean, cucumber, and corn were planted in different soils known to contain heavy natural infestations of particular plant parasitic nematodes. In the cases of watermelon, cucumber, and soybean, the numbers of root-knot nematode galls were greatly reduced in plants from treated seed. With soybeans planted in soil initially rich in *Meloidogyne arenaria*, seed treatment increased the number of plants per plot surviving to time of sampling, the frequency of rhizobia root-nodules, and root and shoot growth.

Introduction of a protective chemical directly into seeds permits use of a precise, calculated, control rate concentrated at the site of potential attack. Thus, worker safety and environmental safety are enhanced without sacrificing pest control.



Extent of protection against the fungus *Rhizoctonia solani* by Collembola insect is illustrated by these cotton plants growing in soil infested with the fungus. The second row from right is with untreated soil, whereas the other plants are in soil in which Collembola insects were added.

## Enhancing Nitrogen Fixation by Peanuts and Soybeans

Current research at Auburn is seeking compatible fungicide-rhizobia combinations for use with soybeans and peanuts. Such a combination is needed because the nitrogen-fixing bacteria rhizobia associated with root nodules of legumes are required for nitrogen fixation, and seed-applied fungicides are often required for adequate crop emergence. Compatibility is the key to success, since many fungicides are toxic to the rhizobia.

To date, pentachloronitrobenzene (PCNB) has been least toxic to peanut rhizobia, while thiram has been least toxic to soybean rhizobia. In peanuts, however, a natural seed factor has been detected that is toxic to the rhizobia. The presence of this factor, which presently is unidentified, complicates treatment of peanut seed with a fungicide-rhizobia combination. Methods for the removal of the factor from seed before planting are being investigated. Perhaps the best that can be hoped for, at least with peanuts, is the pretreatment of seed with nondamaging fungicides, followed by application of rhizobia just prior to planting.

## Friendly Insects for Cotton Disease Control?

Some soil-inhabiting insects may be beneficial to cotton plant growth. Ecological investigations relating to root diseases have revealed for the first time that minute insects of the Order Collembola (springtails) are attracted in large numbers to the rhizosphere (root-soil interface) of cotton seedlings where they protect roots from the damping-off disease fungus, *Rhizoctonia solani*. Studies have shown that two collembolan genera, *Proisotoma* and *Onychiurus*, are prevalent in cotton

field soils and do indeed feed upon fungi. When the insects were added to *Rhizoctonia*-infested soil in numbers of 450 to 900 per pound of soil before cotton was planted, the percentage seedling emergence was increased, disease severity reduced, and plant growth enhanced. In soil without added Collembola, 90 percent of the seed or emerged plants were killed by the pathogen. Large populations of these insects are promoted by dense root systems and high organic matter content of soil.

## Lignocellulose + Microorganisms = Energy

Agriculture's role in providing mankind with food and fiber may be expanded in the future to include production of energy fuel. Auburn research is already working toward this end. Current emphasis is on the conversion of agricultural lignocellulosic biomass to ethanol and methane by microorganisms growing on a substrate following chemical pretreatment. The pretreatment method renders lignocellulose susceptible to both direct enzymatic hydrolysis and attack by microorganisms capable of producing energy compounds. Most of the research effort to date has been devoted to methane production and to an assay method in screening for fungi with high cellulolytic activity.

## FISHERIES AND ALLIED AQUACULTURES

### Day Length and Tilapia Spawning

Results of Auburn experiments indicate that tilapia can be stimulated to spawn early by varying the day length. Brood fish of the species *Tilapia aurea* and *T. nilotica* were held in troughs located indoors in a light controlled chamber. Temperatures were partially controlled, but unusually



Crossbred broodstock of channel catfish were found to produce more fingerlings than pure broodstock.

cold winter air temperatures dropped water temperature below 60°F on two occasions. The experiment began in September and continued until early June, with photoperiod lengths of 13 hours per day and 10 hours per day tried.

First spawning took place February 26 at a water temperature of 73°F. The 13-hour light day resulted in 67 percent of the tilapia spawning, as compared with only 17 percent from 10 hours of light.

#### Feeding Practices for Better Catfish Production

Twice daily feeding boosted feed consumption and growth rate of catfish by 20 percent over once a day feeding in Auburn pond production studies. This was the result with water temperature of 79°F or higher. As water temperature dropped to 68°F, however, once daily feeding was best, and at colder water temperature alternate day feeding was most productive.

In another Auburn pond feeding trial, channel catfish receiving a 36 percent protein, energy adequate feed did not require satiation feeding for maximum production. Reducing the satiation feeding rate by 12.5 percent did not reduce weight gain. The satiation-fed fish required 15-30 minutes to eat and feed was wasted, whereas the fish fed at the lower level ate their ration in 1-4 minutes with no waste. When a 30 percent protein feed was used, satiation feeding was necessary for maximum weight gain.

Although using floating (extruded) feeds in catfish allows the manager to observe feeding activity of the fish, the extrusion processing is more energy demanding and costs more than pellet (sinking feed) processing. However, a combination of 15 percent floating and 85 percent sinking feed may provide the management benefits of floating feeds and the economic benefits of sinking feeds. The combination was as productive as feeding

the same ration as all floating feed. The fish fed the combination diet would consume the sinking feed first, then eat the floating feed.

#### Genetics Advances in Reproduction, Growth

Fish reproductive performance improvements appear possible through crossbreeding, Auburn results indicate. Crossbred broodstock of 3-year-old channel catfish had more pronounced secondary sexual characters, spawned at an earlier date, and had better spawning success than pure-line broodstock. Egg production and fry survival were also higher with the crossbreds. Thus, crossbred broodstock yielded more fingerlings than pure broodstock.

The male parent of inter-specific crosses between blue catfish and channel catfish had a predominant influence on several growth and developmental patterns. Characteristics demonstrating potential influence were body shape, growth uniformity, and harvestability.

Genetic differences in growth from winter feeding were found among species, hybrids, and races of catfishes, with white catfish showing fastest growth. Large differences in winter growth also existed among races and strains of channel catfish. An ongoing hybridization and selection program will incorporate the traits of improved winter growth into production programs.

#### Aeration and Fertilization of Ponds

Aeration made the difference between success and failure of small channel catfish (*Ictalurus punctatus*) ponds stocked at 8,000 per acre and fed daily. The ponds that received daily nighttime aeration (2-6 hours) had no shortages of dissolved oxygen in water and had 92 percent survival. They produced an average of 4,700 pounds of catfish per acre. Fish mortalities resulted from dissolved oxygen depletion in all ponds of the un-aerated treatment, and survival was 40 percent. This treatment produced only 1,200 pounds per acre and was an obvious economic failure. A

maximum feeding rate of 80 pounds per acre was reached by mid-summer.

Sunfish ponds fertilized 11 times during the growing season with liquid ammonium polyphosphate (13-38-0) at 5, 10, or 20 pounds per acre per application had net production of 250, 260, and 330 pounds per acre, respectively. These findings suggest that 5 pounds per acre per application of liquid ammonium polyphosphate is adequate for woodland ponds with low to moderate fishing. The 20-pound rate is adequate in woodland ponds with heavy fishing.

#### Fish Disease and Parasite Update

It was determined that golden shiner virus disease is probably associated with, and triggered by, environmental stress. This is true particularly when golden shiners are harvested from culture ponds and held under confinement in tanks for several days at which time mortalities due to the disease increase.

Immunological studies demonstrated that fry are capable of developing a protective immune response to bacteria, a fact that is important to fish vaccination programs. Generally, experimental vaccination of channel catfish to bacterial diseases has not been encouraging.

Bullhead catfish collected from a sewage lagoon were found to have a 70 percent incidence of skin tumors around the mouth. A study is underway to determine if some material in the sewage is causing the problem. Bullheads from a nearby clean pond were free of the tumors.

Only one of five anthelmintics tested controlled the Asian tapeworm in golden shiners and other bait minnows. This was Di-N-butyl tin oxide used at a rate of 1 percent in the feed and fed for 3 days.

Electron microscopy has been used to study two new protozoan parasites of fishes. One new species of *Apiosoma* was found to have what appears to be a symbiotic algae living in it. The life history and developmental stages of a new species of *Myxobolus* from the gills of the bluegill were worked out through electron microscopy.

#### Too Much Pressure on Chambers Lake

A significant improvement in the bass population of the 184-acre Chambers County Public Lake could be achieved by a reduction in fishing pressure. This tentative conclusion is from a study of the rate of decline in the catch of tagged bass during a 24-week period, an access creel survey, and an electrofishing population estimate of harvestable sized fish and growth.

The estimated 12.8 harvestable sized bass per acre were subject to an annual exploitation rate of 65 percent. Total annual mortality was estimated to be 79 percent. Therefore, lighter fishing pressure could be expected to improve bass fishing.

#### West Point Reservoir Fish Study

The structure of the largemouth bass population in West Point Lake appears to

be satisfactory, but a greater number of quality size bass (larger than 12 inches) would be desirable. Size distribution of bluegills in the population show there are few of quality size available for capture. Higher density for bass should eventually result in a better population structure for bluegill.

Catch rate of stock-size fish and proportional stock density were compared for daytime and nighttime samples of largemouth bass 8 inches long and bluegill 3 inches long during October 1979-February 1980. Bass showed no difference in catch rate or stock density between day and night catches using electrofishing for 45 minutes. Bluegill were caught in numbers six times greater at night than during the daylight hours, but showed no difference in stock density.

### Getting Maximum Tilapia Reproduction

Of four management methods tried for hatchery production of 2-inch size *Tilapia aurea* fingerlings, egg collection, incubation, and transfer to fry rearing ponds gave the highest yield per brood fish. However, the difference between this method and fry collection and transfer was small (not significant). Leaving the young in the spawning pool until a size of 2 inches was reached resulted in a significantly lower yield per brood fish.

Fry stocked in rearing pools at two densities, 253,000 and 506,000 per acre, grew to a size of about 2 inches in 30-50 days. Growth was significantly faster at the lower rate, but 45-50 days were ample to permit a 2-inch size fingerling to be produced at the higher density. Mixing fry of 4 and 7 days of age had no effect on survival or growth as compared to stocking the same age fry (either 4 or 7 days old).

Transferring tilapia fry from spawning pool to rearing ponds resulted in the highest yield of fingerlings per brood fish.



### Improving Bream Fishing in Ponds

Because of the principles involved in growth, reproduction, and mortality, it does not appear possible to have outstanding bluegill and bass fishing simultaneously in the same pond. Management practices that alter the predator-prey relationship to produce better bluegill/redear sunfish fishing in farm ponds stocked with bass and bluegills include: (1) stocking adult bass with bluegill fingerlings at the recommended rate and time, (2) limiting the harvest of bass in established bass-bluegill ponds, and (3) stocking additional prey and predator species into established bass-bluegill populations.

One way to get larger bluegills is to stock adult bass with bluegill fingerlings. Standard seine sampling and catch and draining records document the altered size structure that results in populations where largemouth bass make up about 20 percent of the total fish biomass. The same result can be achieved by restricting bass harvest in established bass-bluegill populations. This management provides an annual "excess-production" of about 9 pounds of bass per acre.

Threadfin shad have been characterized as an ideal prey species for largemouth bass. Its introduction into established bass-bluegill ponds has resulted in a significant reduction in bluegill biomass and an increase in the number of intermediate size bluegills. As a result, the catch of bluegills decreased.

The addition of fingerling largemouth bass of the Florida subspecies to bass-bluegill populations has in some instances apparently altered the genetic composition of established bass populations. Yearling bass raised in hatcheries on pellets and stocked in the fall suffered a higher rate of total mortality than did native bass of the same size, and therefore may not contribute significantly to bass biomass.

## FORESTRY

### What Stand Density is Best?

When trees are grown in crowded stands, the individual trees do not produce as much wood as individual trees in sparse stands. However, the crowded stand is likely to produce more wood per acre. The problem is that trees from the crowded stand may have trunks of such small diameter that they have little commercial value.

Somewhere between the sparse and the crowded stands is the stand of trees that will produce the maximum amount of commercially valuable timber. How to predict this "ideal" stand density is being sought in a study comparing the tree crown space occupied by a tree growing without any surrounding trees and by those growing in crowded stands. The crown that is not being crowded by other trees will produce a tree trunk of maximum size, while the crowded trees will produce trunks of a lesser thickness, depending on the degree of crowding. These comparisons will be used to determine the amount of crown space needed by a tree to produce the most desirable trunk size in a given period of time.

### Predicting Pine, Poplar Height Growth

Data on height growth of loblolly pine and yellow-poplar, two of our fastest growing commercial tree species, are being used to develop methods of pre-

Crown space used by tree in crowded stand (top) can be determined when the tree has been removed (bottom). Such measurements are being used to develop methods of predicting the most productive stand density.





Comparisons of energy requirements for heating and cooling these test houses constructed with different insulation materials and different exterior and interior building materials should provide guides for most energy-efficient homes.

dicting rate of growth. Such a management tool would be valuable for southern forest managers.

The largest data set of its kind, U.S. Forest Service measurements on pine plantations ranging from Arkansas to North Carolina, was used to study loblolly pine height growth. These data were used to define growth curves and to develop site index (height at age 25) prediction equations. The study identified the need for separate site index prediction equations or curves for stands on heavy clay soils of the Interior Flatwoods of Alabama and Mississippi. Using curves designed for general use may underestimate the true site index by as much as 20 feet on these heavy clay soils.

Data are being gathered from yellow-poplar trees scattered throughout most of the southern two-thirds of Alabama to develop accurate site index prediction tools for this valuable species. Some 100 additional trees will be added to almost 100 which have already been felled and cross-sectioned. This study will also develop information for predicting yellow-poplar site quality from soil and topographic information. This species can grow amazingly fast on some sites. One tree was 102 feet tall and 20 inches in diameter at age 28.

#### Christmas Tree Production Improved

The expanding Christmas tree industry in Alabama is being aided by the results of field evaluations of cultural methods. Although both Virginia pine and Arizona cypress have produced high grade trees in Alabama trials, emphasis is on Virginia pine because it is an excellent species in all areas of Alabama where pines will grow. This species will produce high quality trees that can compete with northern conifers.

In central Alabama, Virginia pine planted on an old field site of medium quality will produce Christmas trees in approximately 5 years — provided good care is given from planting to harvest. One-year-old seedlings from a good seed source should be planted in square spacing patterns. Spacings of 6 x 6, 7 x 7, and 8 x 8 feet are commonly used. Narrow spacings are used when hand equipment is to be used for tree care and wider spacings are used when farm tractors are to be used.

Control of Nantucket tip moths and pine sawflies, destructive insects that attack Virginia pines, has been accomplished in tests by spraying with dimethoate. Results show that shearing is essential for shaping the growing trees, with two shearings per season needed after the trees have been planted for 1½ growing seasons. The first shearing of a season should begin about April 15 in central Alabama, April 7 near the Gulf Coast, and April 22 in the Sand Mountain area. The second shearing should begin about July 15 in central and northern Alabama and about July 8 near the Gulf Coast.

#### Energy Efficient Construction

Home builders may soon know what type of construction offers the most energy efficient heating and cooling—without excess home building costs — thanks to an innovative project now underway at Auburn. Twelve small buildings involving different floor, wall, and ceiling systems are providing direct comparisons of energy required to maintain inside temperatures of 66°F in winter and 76°F in summer. Cost of structural and insulation layers will offer a comparison among the various house cells defined by the floor, walls, and ceiling.

Brick and plywood siding exterior walls will be evaluated, both with gypsum board interior finish. Wall sheathing will be either half-inch building board (black board), half-inch plywood plus felt, or ¾-inch styro board. Wall insulation being tested includes both 4- and 6-inch fiberglass with 2 by 4 and 2- by 6-inch stud wall and ¾-inch styro board with concrete block wall. Ceiling insulation will consist of 6-inch fiberglass in all units, but building board cover over the insulation will be compared to insulation that is not covered.

Two standard type floor structures are being evaluated: (1) 4-inch concrete slab; and (2) 24-inch above-ground wood frame floor with half-inch plywood subfloor and ¾-inch board underlayment with 6-inch fiberglass insulation. Finish floor coverings of mat with carpet will be compared to wood floors.

The various combinations being tested should provide a realistic guide for the building trade and for homeowners to use in deciding on building systems to use.

Since relative costs of constructing each type will be available, potential buyers can choose the system that offers a desired ratio of construction cost to the cost of required energy for heating and cooling.

#### Nursery Weed Management Changed by AUFCC

The suspension of 2,4,5-T for forestry uses resulted in a tremendous surge of interest in the Auburn University Forestry Chemicals Cooperative (AUFCC) in 1979. Membership increased from 14 to 18 forest industries during the year.

Dramatic changes in forest nursery weed management have come about because of AUFCC research that led to registration of several herbicides to replace hand weeding, mineral spirits, and methyl bromide for weed control in pine nurseries. A major breakthrough came when bifenoxy (Modown), included in the trials in 1974, demonstrated excellent weed control with no damage to pine seedlings. It was registered for nursery use in 1978. This led to examining more compounds in the same herbicide family as bifenoxy, and to the eventual registration of oxyfluorfen (Goal) in July 1979. Oxyfluorfen combines such dramatic weed control with tolerance to pine seedlings that it can be used to control most weed problems in pine seedbeds.

The past year has also seen major changes in the use of silvicultural herbicides. Just as the Cooperative was installing initial silvicultural herbicide tests, the Environmental Protection Agency announced the suspension of 2,4,5-T for forestry uses. Over 20 studies involving site preparation, release, and herbaceous weed control were installed across the southeastern region in 1979.

#### Small Skidders for Logging Small Tracts

The potential of a small skidder, the German made Holder A55F, for logging small tracts was investigated in cooperative studies with the USDA Forest Service Engineering Group. Interest in the small machine is because the bigger skidders, generally used because of their flexibility in harvesting on a variety of sites and their generally lower cost per unit of volume skidded, lose their advantages when logging small tracts of timber common in most of the South. Also, large machines

frequently cause damage to residual trees during thinning operations because of their lack of maneuverability. It was hoped that the 48-horsepower Holder, an articulated, four-wheel drive machine, would provide one of the missing pieces in the total harvesting picture.

Even with the relatively low cost machine (\$24,000), cost per 100 cubic feet of wood (a cunit) was fairly high, \$9 for a 100-foot skid to \$15 at 500 feet. Productivity varied by skidding distance, but averaged about a cunit per scheduled hour.

As studied, the Holder was equipped with a Farmii cable winch. Considerable time was spent by the operator attaching the cable to the trees for skidding; therefore, the addition of a hydraulic grapple in place of the winch was simulated. This modification increased production about 50 percent and lowered the cost per cunit to \$6 for a 100-foot skid and \$12 at 500 feet. These costs are reasonable at short distances.

In addition to its competitive production and costs, the small Holder tractor, when equipped with a grapple, should offer good maneuverability, particularly in dense stands where its small dimensions prove advantageous.

Studies with elderly persons revealed that most were getting adequate protein in their diets, but consumption of other nutrients was inadequate for certain groups.

## HOME ECONOMICS RESEARCH

### Solar Water Heating Investigated

Auburn work under a new regional housing project is currently evaluating residential solar water heating in Alabama. Some 80 state households with solar water heaters have been identified through cooperation of the Alabama Solar Energy Center at the University of Alabama-Huntsville.

Preliminary analysis of data from telephone interviews has indicated that most of the solar system owners were highly knowledgeable about their systems. Many either directed or participated in the solar installations.

Other types of data being sought include (1) consumer decision-making related to the choice of an alternative energy source system, (2) manufacturers' and sellers' claims about the systems, (3) ease of installation, (4) knowledge about maintenance and warranties, and (5) performance characteristics of the systems.

### Diet-Health Relationships

Food intake and nutritional data on 100 girls, 11 to 13 years old, hint at an association among diet, weight, and blood triglyceride and cholesterol values that may be related to later-year heart disease of low income blacks.

Intake of food and consumption of Kcal, protein, calcium, and vitamins A and

C increased each year as the subjects went from 9 to 11 years old. The mean energy intake was 2,600 Kcal for black girls and 2,260 Kcal for white girls at age 11. The blacks also weighed more than the same age white girls. Girls in the moderate income strata had higher mean body weights than their low income counterparts. Blood pressures were in normal ranges, but a large percentage (53 percent) of black, moderate income girls rated in the upper quartile of blood pressure. Triglyceride, cholesterol, and hemoglobin values increased with age. White girls had higher triglyceride and hemoglobin values, but black girls had higher cholesterol values over the 3 test years.

### Nutrition Varies Among Older Persons

Although most of the elderly persons surveyed about nutrition were getting adequate protein in their diets, consumption of dietary iron and calcium was low for certain segments. Calcium intake was low for 42 percent of the black women, and thiamin and niacin consumptions were generally low for black men. Dietary iron consumption was adequate for 79 percent, while 93 percent met or exceeded two-thirds of the recommended dietary allowance for protein. Diets poor in nutrient quality were found more frequently among black subjects than among whites and were associated with eating less than three full meals per day and eating alone.

Results of the survey among participants in the Alabama Title VII Nutrition Program for the Elderly revealed that fewer males (55 percent) than females (91 percent) had acceptable hematocrit values. Hemoglobin values were acceptable for 63 percent of the whites but only 44 percent of the blacks. More than a third (37 percent) of the black females were more than 20 percent heavier than the desirable weight standard for their heights.

### Finishes Affect Burning Mechanisms

Light exposure had no effect on pyrolysis products of cotton duck cloth with a flame retardant finish, according to results of gas chromatography tests. Treating for flame retardancy did affect the decomposition products from burning, and there was a variation between the two flame retardancy treatments used.

A wrinkle resistant finish did cause a change in the pyrolysis products of the fabric, and light exposure caused a further change. Using a polyethylene finish caused no changes during burning, either before or after light exposure.

## HORTICULTURE

### Better Shaped Azaleas

A more dense, compact azalea plant can be produced by using a new chemical pinching agent called Atrinal. Plants also have more shoots for potential flower production. Vegetative shoot growth at flowering, which often obscures the flower, is also reduced. Chemical pinching eliminates the time consuming, wasteful, and





Bags of human hair hanging in trees were found to keep deer out of plum orchards and prevent damage to young, developing trees.



expensive task of mechanically cutting the plant with shears to influence its growth.

Eight chemical pinching agent materials have been tested at Auburn, and Atrinal gave the best results. Its one disadvantage, inhibition of growth, was not found to have a long term effect on plant growth.

#### Peaches Perform Well in Wiregrass

The potential for producing peaches for both fresh market and processing is unlimited in the Wiregrass area of Alabama. This region has the advantage of being free of spring frost in most years at the time when most peach producing areas are subject to frost damage during or just after bloom. What has been needed is knowledge of varieties adapted to this southern area of the State, and this has been supplied by a variety evaluation planting at the Wiregrass Substation. Twenty-six varieties, grown under standard commercial conditions, were rated for date of bloom, date of harvest, fruit size, skin color, flesh firmness, stone freeness, dessert quality, flesh color, and yield. Some varieties that performed well in other respects proved unacceptable because of susceptibility to bacterial leaf spot or bacterial fruit spot, or both. Varieties that performed best for commercial production were Springcrest, Springgold, Maygold, Sentinel, La Gold, Keystone, Winblo, and Redskin.

#### Human Hair Repels Deer

How human hair can be used to prevent deer damage to fruit orchards and vegetable fields has been demonstrated at units of the Agricultural Experiment Station. The method was tried in response to severe grazing damage to the newly planted plum orchard at the E. V. Smith Research Center.

To test the repellent effect of human hair, as reported from other sources, 20-

gram samples of hair were made up in small bags. One bag was suspended in each plum tree in one experiment, and in the perimeter trees in another. Complete protection from deer damage was achieved by either method. Subsequently, similar results were recorded in other research plantings and grower orchards.

Complete and partial protection was achieved when 20-gram bags of human hair were suspended on bamboo canes spaced 10 feet and 20 feet, respectively, along the perimeter of  $\frac{1}{2}$ -acre tiers of southernpeas. At the greater spacing, deer would enter the planting midway between the hair samples. Complete protection was provided to a sweetpotato planting by suspending hair bags 20 feet apart along the perimeter.

Research is continuing to test the length of time that hair retains its repellent property.

#### Insect Resistance in Southernpea

That resistance to the cowpea curculio in certain breeding lines of southernpea is due to low levels or the absence of volatile attractants was first demonstrated at Auburn in 1979. Using a specially designed apparatus, vapor extracts of resistant and susceptible southernpeas were injected into the air stream to which the insects were subjected. The curculios were forced to choose between the attractant or the air without the attractant. A significantly greater number of curculios chose to follow the air stream containing volatiles from the susceptible pods than those from resistant pods. Greater numbers of insects were trapped in lines with air alone than in lines to which volatiles from resistant pods were added.

These results explain that the chemical basis for non-preference resistance in some breeding lines is due to low levels or the absence of attractants in the pods. Not only will screening plants for the absence

of attractants aid in breeding curculio resistant varieties, but the use of such attractants in conjunction with insecticides could give more efficient control of target insects in pest management programs.

#### Wild Tomato Aids Breeding

The wild Peruvian tomato *Lycopersicon hirsutum*, long known to possess valuable traits for disease and insect resistance, is providing valuable genes for Auburn tomato breeding work. This species has been observed to be resistant to tobacco mosaic virus, to *Alternaria* leaf spot, to the tomato fruitworm or corn earworm, to the tomato hornworm, and to spider mites. Its current use at Auburn is for resistance to the leaf miner fly, *Liriomyza munda* (Frick), a major pest of field grown tomatoes.

The F<sub>1</sub> species hybrid (*L. esculentum* × *L. hirsutum* f. *glabratum* P.I. 134417), as well as the reciprocal cross, proved to be highly resistant to the leaf miner in greenhouse tests. Both F<sub>1</sub> hybrids were relatively seed and pollen fertile and first and second backcrosses have been obtained. Leaf miner resistant segregates of *L. esculentum* type have been recovered. An additional bonus has been an increase in fruit firmness, in soluble solids up to 13.0 percent, and in viscosity—important quality measures.

#### Russet Resistance of Golden Delicious Apples

The Golden Delicious apple is much easier to grow and produces larger crops than the Red Delicious, but its susceptibility to russetting under Alabama weather conditions limits its use. But results of variety evaluations at the Piedmont Substation identified varieties with most russet resistance.

All strains tested except one showed some degree of russet development. Unfortunately, the one variety showing no russet (Prime Gold) proved to be unsatisfactory in other characteristics. When all criteria are considered, Magnolia, Smoothee, Clear Gold, Van-Well Golden Delicious, and Bountiful Ridge Yellow Delicious are the varieties that performed best overall. Of these, Magnolia and Smoothee came closest to acceptable commercial type.



## POULTRY SCIENCE

### Time of Insemination Affects Fertility

Late afternoon and evening insemination resulted in higher egg fertility than morning and mid-day inseminations. Lower fertility levels from morning and mid-day inseminations were associated with time of oviposition (laying of eggs). Laying in less than 3 hours after insemination was found to reduce fertility. Mid-morning and mid-afternoon inseminations had similar fertility results. Another finding was that fertility and embryo survival decreased with increasing time of spermatozoa storage in the oviduct.

### Intermittent Light Aids Egg Production

Exposing hens to 1 hour of dark during the normal cycle of a 15 hours light-9 hours dark photoperiod boosted egg production. Cycles of 1 light: 1 dark: 13 light: 9 dark resulted in best egg production. The 1-hour dark period in the morning improved egg-shell quality, in comparison with a 1-hour evening dark period. A 1-hour light period during the normal subjective night was found to decrease egg production.

### Shell Quality and Fertility

Factors that reduce shell quality were found to be associated with significant reduction in fertility of eggs from broiler breeders. Such fertility reductions apparently reflected the inability of females producing eggs with poor shell quality to maintain fertility for as long as 3 days after insemination. In contrast, females producing eggs with good shells were able to maintain 100 percent fertility for 6-7 days.

Poor shell quality also caused increased incidence of early and late mortality, and hatching time was 5-7 hours longer than for eggs with good quality shells. With additional hatching time provided, however, quality of chicks was not reduced because of poor shell quality.

### Photoperiod Affects Egg Body Checking

Adjusting the periods of light and darkness (photoperiod) may offer a method of reducing the incidence of body-checked eggs and thereby eliminate price penalties. The results suggest that body-checked eggs are produced when egg shells, but not shell membranes, are broken in the uterus. The findings further suggest that hens under darkness during this critical time are less likely to break the egg shells.

That the timing can be controlled is indicated by results when the photoperiod was reversed. Average time of lay of body-checked eggs was thus changed from 7:11 a.m. to 6:35 p.m. Extending the photoperiod increases body checks, whereas reducing it decreased the incidence of body-checked eggs.

### Turkey Blood Pressure Under Stress

Both high and low blood pressure strains of turkeys responded similarly to exercise, fright, mating, and diurnal changes. Exercise caused a rapid increase in heart rate with a drop in blood pressure. Fright showed the same heart rate response, but with increasing blood pressure.

Blood pressure required to rupture the abdominal aorta was 1,500 mm of mercury, as compared with 800 mm to rupture the thoracic aorta. There was no correlation between rupture pressure and blood pressure or severity of atherosclerosis.

The hypertensive strain of turkeys is known to be more susceptible to heat stress, and in the past it has suffered a higher incidence of dissecting aneurysm than the hypotensive strains. However, there has been no correlation between the severity of atherosclerosis and hypertension or hypotension.

Egg fertility can be improved by inseminating hens in late afternoon and evening rather than in morning and mid-day, Auburn results revealed.

## ZOOLOGY-ENTOMOLOGY

### Parasite for Whitefly Control

The citrus whitefly, *Dialeurodes citri* (Ashmead), has long been a troublesome pest on many Alabama landscape plants, particularly gardenia, ligustrum, and viburnum. No native parasites have been reported for this whitefly. In 1978, the exotic parasitic wasp, *Prospaltella lahorensis* Howard, which originally was discovered in Pakistan, was introduced into three areas of Alabama as a possible biological control agent of citrus whitefly. The releases in Auburn, Birmingham, and Huntsville have resulted in populations of the wasp becoming established and overwintering. Natural spread of the parasite has begun and will be monitored through 1980-81. Similar releases in Florida have resulted in reduction of whitefly numbers by approximately 95 percent during the past 2 years.

### Wild Turkey Poult Losses

Recent Auburn studies have shown that the loss of wild turkey poults during the first 2 weeks after hatching is generally the number one limiting factor on Alabama populations. Data on 372 poults, from nests of radio instrumented hens between 1975 and 1979, revealed that 71.3 percent were lost during the first 2 weeks. However, there was no way to collect adequate data on causes of these losses until miniature radio transmitters and harnesses weighing approximately 2 grams that can be carried by day-old wild turkey poults were tested and developed during 1978-79. This made possible a concentrated study of the causes of early poult losses beginning in 1980. Limited results from 1979 suggest predation is the number one cause of loss; however, weather, habitat condition, and diseases and parasites also may prove to be important interacting factors.

### Recovery from Early Season Square Removal

The potential of short season cotton varieties to reduce late season insect problems and weather problems associated with late harvests is being investigated in Auburn research. Of particular interest is whether short season cotton would be able to recover from square damage that occurred during the relatively short period of peak squaring, which would greatly affect its value.

Tests at the Tennessee Valley Substation in 1979 measured the ability of short season cottons (semideterminate varieties MN220 and MN235 and the determinate varieties GP3774 and GP3755) to recover from early season square removal. When no squares were removed, the MN varieties produced more cotton than the very determinate varieties or Coker 310 (a rapid fruiting, but relatively indeterminate variety). The GP varieties stopped squaring during extended dry weather in late June-July and never resumed squaring. When squares were removed from 1-5





Wildlife scientists can accurately predict the proportion of overwintering woodcock that will nest in Alabama, using a new Auburn-developed technique.

weeks, the determinate varieties quickly recovered and produced squares at a very high rate, despite the dry weather. When squares were removed for 4 weeks, GP3774 produced more cotton by the end of October than any variety in the test.

In small field plots, up to two tarnished plant bugs per row foot during the first 2 weeks of squaring failed to reduce yield or maturity of cotton. During the third week of squaring, however, yields and maturity were significantly reduced by two to six bugs per row foot. No yield differences were observed with different numbers of bugs during the third week of squaring.

Low rates of methomyl were moderately effective against plant bugs and relatively non-lethal to beneficial insect populations. Permethrin, dimethoate, chlorpyrifos, and EPN + methyl parathion have been effective against plant bugs.



#### Mosquitoes and Dog Heartworm

An investigation of the susceptibility of different strains of mosquitoes to infection with dog heartworm provides better understanding of the transmission of this nematode parasite by various mosquito species. In some mosquitoes the parasites failed to develop due to entrapment in the coagulated blood of the mosquito midgut. In others, even though the parasites successfully reached the excretory organs of their hosts (where they would normally complete their transformation to the infective stage), encapsulation and interrupted development caused high parasite mortality in the more resistant strains. This helps to explain why a given mosquito species may be an important vector of dog heartworm in one area but not in another.

#### Predicting Woodcock Populations

Investigations concerning breeding activities of American woodcock in Alabama have apparently led to development of techniques allowing wildlife scientists to accurately predict the percentage of the overwintering woodcock population that will nest in Alabama. Data from 1979-80 suggest that as high as 20 percent of the females present in Alabama after January 15 will nest here. Estimates are based on the presence of sperm in the uterovaginal glands of the female correlated with the size of the largest developing ova.

Mosquitoes collected from this trap were used in tests that showed how some strains of the insect were more important vectors of dog heartworm than were other mosquito species.

#### Christmas Tree Insect Control

The Nantucket pine tip moth was the most important Virginia pine tree pest encountered in 1979 research. Larvae of this insect tunnel and feed inside terminal leaders and lateral twigs of young trees causing dieback, resulting in reduced height growth and poorly formed, unmarketable trees.

Biology studies found that the tip moth routinely completes three generations per year in the Auburn area, with a small segment of the population completing a fourth. Timing of insecticidal sprays in relation to moth flight is necessary for effective control. Major moth flight periods in 1979 in the Auburn area were March 12-30, May 27-June 10, and July 20-August 3.

#### Hormonally Based Insecticide for Crickets?

A new Auburn project involving the natural compounds precocenes is looking toward development of an insect-specific insecticide for the striped ground cricket. Such an insecticide might need to be applied only during a sensitive period of the pest's life cycle to drastically reduce its population and prevent damage to white clover seedlings, a problem common in the Black Belt area.

The precocenes, originally isolated from plants of the genus *Ageratum* (common bedding plants), have been found to inhibit or reverse certain developmental processes in several species of insects. This comes about by an antagonistic effect on the endocrine organ, the corpus allatum, which produces juvenile hormone, an important regulator of insect growth and development. This hormone is required by most insects in the formation of egg yolk, which is necessary for egg maturation. Current work is determining how precocenes affect egg production of the striped cricket.

#### Continuous Darkness May Damage Eyes of Poultry

One of the potential problems from rearing poultry under lighting — enlarged eyes and blindness of chickens and turkeys — is being investigated in a study by the departments of Zoology-Entomology and Poultry Science and the School of Veterinary Medicine.

Enlarged eyes had flatter, thinner, and less rigid corneas, as well as various retinal pathologies and reduced blood supply. Unlike human glaucoma, however, the eye enlargements were independent of intraocular pressure. Inheritable low blood pressure further decreased the intraocular pressure but accentuated the eye enlargement in turkey poults.

Growing chicks were more susceptible to the darkness-induced eye enlargement than aged chickens. The eye enlargement in growing poultry is suspected to be related to abnormal ocular development, brought on by either ocular blood flow or prostaglandin synthesis.

# Support for Research Departments



TOP: Tillage and traction research is carried out at the USDA-SEA National Tillage Machinery Laboratory. ABOVE: Exhibits are one tool used by Department of Research Information in telling the public about Auburn research. BELOW: USDA Forest Service Personnel on campus are involved in forest engineering and other forestry research.

Project leaders in the 11 subject matter departments were aided in their 1979 research efforts by four support units: (1) the Department of Research Data Analysis, whose statistical scientists use latest computer techniques in analyzing research data for their specific meaning; (2) the system of outlying units that provides natural resources and personnel for studying agricultural problems under a wide variety of soil and environmental conditions representative of all areas of Alabama; (3) the Department of Research Information, which provides editorial, photographic, art, and publishing expertise to get usable research information to appropriate audiences around the State and Nation; and (4) the Department of Research Operations (highlighted in an earlier section of this report), which provides such services as building construction and maintenance, feed production and harvesting, and facilities upkeep.

Units of federal agencies that cooperated with the Agricultural Experiment Station in specialized areas of research included: (1) the National Tillage Machinery Laboratory of the USDA Science and Education Administration, which has facilities and staff to study various tillage and traction problems as related to agriculture; (2) the USDA-SEA group of soil and crop scientists who are involved with soil fertility, soil physics, and crops research; (3) the Environmental Service Center of the U.S. Department of Commerce, which helps researchers relate their research to environmental conditions that are encountered throughout Alabama; and (4) USDA Forest Service personnel, who are involved with forest engineering and other forestry research.



ABOVE: Soil and crop scientists of USDA-SEA use the rhizotron and other sophisticated scientific equipment in research on soil fertility, soil physics, and crop production. BELOW: The computer is an important tool used by Department of Research Data Analysis in interpreting results of Experiment Station research.



# Active Research in 1979

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## AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

### Crops, Livestock, and Poultry Management

Changing Role of Selected Agricultural Credit Agencies

Development of Models for Evaluation of Credit Worthiness of Agricultural Borrowers  
Efficiency of Identification, Assembly, and Transportation of Cotton to Mills and Export Outlets

Freshwater Food Animals

Supply, Pricing, and Marketing Alternatives for Cattle, Beef Systems in the South

Characteristics of Liquid Fertilizer Users

Regional Resource Allocation Model for the Livestock Sector

Economic Aspects of Commercial Turfgrass-  
sod Production in Alabama

### Marketing

Alternative Structures for Increasing Efficiency in Inter- and Intra-regional Grain Marketing Systems

Marketing Performance of Selected Milk Pricing Systems for the Southern Region

Price Discovery and Informational Flows for Major Agricultural Commodities in the Southern Region

Short-run and Long-run Demand for Broiler Meat

Organization and Efficiency of the Fruit and Vegetable Production-marketing Subsector in the South

Development, Production, and Marketing of Christmas Trees

Potential for Direct Marketing of Fruits and Vegetables in Chattanooga, Tennessee Area

### Resource Use and Planning

An Econometric Analysis of Variations in Rural Land Value

Effects of Investments in Recreational Resources on Income and Employment in Barbour and Marshall Counties

Efficient Vehicle Routing and Scheduling for Agribusiness Firms and Public Services

Estate Planning for Farmers

Financial Management and Farm Growth

Law for the Alabama Farmer

Changing Structure of Agriculture: Causes, Consequences, and Policy Implications

The Status and Relation of the Coastal Zone to Alabama's Economy

### Rural Development

Defining and Achieving Life Goals

Implementation of Continuance Planning in Outdoor Recreation

Public Services and Economic Development in Rural Communities

Social Organization for Development of Low Income Rural Counties

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## AGRICULTURAL ENGINEERING

### Crop Production

Engineering Systems and Energy Needs for Cotton Production

Soil Surface and Profile Modification for Improving Soil-water Relationships

### Farm Machinery

Automatic Direct Digital Control for Steering Tractors

Determining Farm Machinery Reliability for Southeast Field Conditions

### Fish Production

Freshwater Food Animals

### Grain Quality

Grain Quality Inspection Systems

### Irrigation

Evaluation of Irrigation Potential for Alabama Trickle Irrigation in Humid Regions

### Nut Culture

Factors Influencing Vegetative and Reproductive Development of Young Pecan Trees

### Poultry Production

Reproduction Performance of Artificially Inseminated Broiler Breeders Maintained in Cages

Utilization of Solar Energy in Poultry Production

Environmental Influences on Poultry

### Soybean Production

Herbicide-tillage Interactions on Soybeans and Soil in Monoculture System

### Waste Control

Animal Waste Utilization and Treatment Systems

Conserving and Feeding Crop Residues

Evaluation of Wastewater Reuse Lagoon Systems

Process for Making Animal Feed from Waste from Cattle in Production Units

Development of An Integrated System for Total Utilization of Swine Waste

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## AGRONOMY AND SOILS

### Beef Production

Beef Production on Selected Forage Systems  
Developing Pasture, Hay, and Silage Management Systems for Cattle

### Cotton Production

Evaluation of Cotton Varieties and Strains

### Dairy Production

Energy and Protein Levels in Silage Concentrate Blended Rations for Dairy Cows

Evaluation of Phalaris and Phalaris-ladino Clover Pastures for Dairy Cattle

### Forage Crops

Chemical Profile and Nutritive Value of Forage Genotypes and New Forage Varieties

Establishment, Management, and Utilization of Improved Forage Species and Cultivars

Forage Legume Viruses

Plant Germplasm — Its Introduction, Maintenance, and Evaluation

Productivity and Quality of Phalaris, Annual Cool Season Grasses, and Legumes

### Grain Crops

Grain Crops Cultivars and Experimental Strains Testing

### Plant Breeding

Breeding Phalaris and Tall Fescue for Improved Winter Forage Production

Breeding White Clover for Persistence and Yield

Breeding and Evaluation of Low-tannin Sericea and of Interspecific Vetch Germplasm

### Soil Chemistry, Microbiology, and Fertility

Availability of Residual and Fertilizer Phosphorus

Diagnosis and Correction of Manganese and Molybdenum Problems in Legumes

Distribution and Significance of Mineral Components in Alabama Soils

Effects of Soil Acidity and Calcium on Soil Solutions and Yield of Crops

Soil Fertility and Fertilizer Requirements for Vegetable Crops

Soil Testing and Plant Analysis

The Nature of Soil Acidity and its Effect on Agronomic Crops in Alabama

### Soil Physics

Movement and Retention of Water and Solutes in Selected Southern Region Field Soils

Water Movement in Selected Alabama Soils

Water Transport Phenomena in the Soil-plant System

### Soybean Production

Cultural and Environmental Factors Influencing Soybean Yields in Alabama

Enhancing Biological Dinitrogen Fixation in Soybeans and Other Legumes

Herbicide Tillage Interactions on Soybean and on Soil in Monoculture System

Soybean Variety and Experimental Strain Evaluation Program for Alabama

### Turfgrass

Production and Management of Turfgrass

### Weed Science

Biology and Control of Weeds

Competitiveness and Control of Weeds in Soybeans

Cultural and Environmental Effects on Herbicide Persistence

National Agricultural Pesticide Impact Assessment Program

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# ANIMAL AND DAIRY SCIENCES

## Biochemistry

Kinetics of Bacterial Thymidylate Synthetase and its Inhibition by Substrate Analogs  
Metabolic Role of Uric Acid Riboside and Nucleotides in Cattle Red Blood Cells  
Oxidation and Conjugation of Carcinogenic Hydrocarbons in Marine Animals  
Relationship of Diet to Cholesterol Concentrations, Pool Size, and Turnover in Tissues of Rats

## Breeding

The Effects of Breed and Breed Crosses on Milk Production and Other Production Factors in a Grade Beef Herd  
Evaluation of Crossbreed Beef Cattle under Different Growing and Finishing Regimes  
Genetic Improvement of Efficiency in the Production of Quality Work  
Parameters Associated with Growth Rate Curves in Beef Cattle  
Performance Testing of Prospective Sires as an Aid to Selection

## Dairy Production

Buffered Diets for Dairy Cattle Confined on Concrete  
Comparison of Urea and Soybean Meal in a Silage-based Complete Feed for Dairy Cows  
Energy and Protein Levels in Silage-concentrate Blended Rations for Dairy Cows  
Evaluation of Phalaris and Phalaris-ladino Clover Pastures for Dairy Cattle  
Relation of Feet and Leg Conformation to Lameness Diseases of Dairy Cows Confined to Concrete Floors  
Relationship Between Bacterial Quality of Raw Milk and Subsequent Pasteurized Milk  
Significance of Microflora of Healthy Bovine Udders in Mastitis Control

## Meat Science

Marketability of Beef Produced Under Forage-grain Management Systems

## Physiology

Effects of Environmental Stress and Endocrine Function on Growth and Reproduction in Swine  
Selected Reproductive Phenomena in Cattle and Swine

## Ruminant Nutrition

Beef Production on Selected Forage Systems  
Effect of Feeding Systems and Animal Size on Efficiency of Beef Production  
Evaluation of Pastures for Yearling Beef Steers  
Gluconeogenesis and Amino Acid Metabolism in Ruminants  
Growing-finishing Systems for Beef Steers in North Alabama  
Growing-finishing Systems for Steers in the Coastal Plains Area  
Increasing Protein and Energy Utilization by Beef Cattle  
Systems for Growing-finishing Stocker Cattle in the Gulf Coast Area

## Swine Nutrition

Nutrition and Physiology of Gestating and Neonatal Swine  
Nutritional Systems for Swine to Increase Reproductive Efficiency

## Waste Management

Animal Health and Food Safety Aspects of Feeding Animal Waste  
Development of an Integrated System for Total Utilization of Swine Waste  
Evaluation of a Lagoon Waste Management and Recycling System for Confined Dairy Cattle  
Evaluation of Wastewater Reuse Lagoon Systems  
Liquid Fuel and Chemical Production from Cellulosic Biomass

# BOTANY, PLANT PATHOLOGY, AND MICROBIOLOGY

## Biological Control

Biological Control of Selected Arthropod Pests  
Diseases

Activities of Nematicides and Fungicides on Non-target Soil Nematodes and Fungi  
Biochemistry and Physiology of *Cronartium fusiforme* on Southern Pines

Disease Control Systems for Peanuts and Soybeans

Ecology and Control of Fusiform Rust on Southern Pines

Ecology and Control of Soil-borne Fungal Pathogens of Forest Tree Seedlings

The Effects of Seed Treatment Fungicides on the Rhizobium Host Infection Process in LDB Legumes

Epiphytology and Control of Apple and Peach Diseases

Epiphytology and Control of Scab and Brown Leafspot on Pecan

Epiphytology and Control of Some Diseases of Peaches and Apples

Forage Legume Viruses

New or Unusual Plant Diseases in Alabama

Plant Diseases in Relation to Forage Crop Breeding

Rhizosphere Ecology as Related to Plant Health and Vigor

Soil-borne Pathogens of Peanuts, Their Complexes and Control

Viral Diseases of Selected Grass: Identity, Control, and Role in Predisposition

Viruses and Mycoplasma-like Organism (MPLO) Causing Diseases of Corn and Sorghum

## Fungi and Mycotoxins

Chemistry and Physiology of Mycotoxins  
Ecology and Taxonomy of Some Alabama Fungi

Mycotoxicology of Stored Feeds and Seeds

Mycotoxins of Corn and Other Feed Grain

Production of Mycotoxin (Other than Aflatoxin) by Fungi Isolated from Cottonseed

## Herbicides

Effect of Chloracetamide Herbicides on Plant Membrane Integrity and Disease Susceptibility

Effects of Herbicides on Submerged Seed Plants

Fate and Effects of Atrazine in Salt Marsh Ecosystems

Minimum Tillage and Double Cropping on Weed Populations and Persistence and Fate of Herbicides

## Morphology, Physiology,

## Taxonomy, and Ecology

Changes in Lipid Metabolism and Competition of Water-stressed and Phytohormone Treated Plants

Distribution and Habitats of Alabama Poisonous Vascular Plants

Effects of Environmental Stress Factors on Some Energy-related Processes of Plants

Floc Formation and Bulking in Activated Sludge Process for Treatment of Textile Wastewaters

Isolation and Identification of Odorous Metabolites of Aquatic Actinomycetes

Water Conservation in Cotton by Drought Induced Leaf Surface Wax Synthesis

Water Transport Phenomena in the Soil-plant System

## Peanuts and Soybeans

Flower and Pod Abscission in Soybean (*Glycine max* (L.) Merr.)

Fungal Spore Germination Inhibitors and Stimulators Associated with Surface Waxes of Peanuts

Implementation of AMI Method for Determining Peanut Harvest Dates in Alabama  
System for Disease Management in Peanuts and Soybeans

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# ANIMAL HEALTH RESEARCH

## Cattle

Bovine Respiratory Viruses: Mechanisms Which Affect Virus Replication and Respiratory Tract Disease

Neurology of the Reproductive System of the Bull

Pathogenesis and Therapy of Intestinal Parasites in Calves

Persistence of Infection in Calves Born to and Nursing Brucellosis-infected Dams

Relationship of Anatomical Conformation of Feet and Legs to Lameness Diseases of Dairy Cows Confined to Concrete Floors

Reproductive Diseases of Cattle

Transmissions of Brucellosis from Cattle to Non-ruminant Wildlife Mammals

## Poultry

Relationship of Blood Pressure to Blood and Aorta Tissue Lipids and Atherosclerosis in Turkeys

## Swine

Factors Affecting the Immune Response of Newborn Pigs

Morphology of Colonic Lesions Associated with Carrier State of Swine Dysentery

## HOME ECONOMICS RESEARCH

### Housing

Housing for Low and Moderate Income Families  
Quality Housing Environment for Low-income Families

### Nutrition

Dietary Fat and Prostaglandin Content of Human Milk  
Effect of Maternal Dietary Lipid on Prostaglandin Content of Human Milk  
Influence of Socioeconomic Factors on Food Habits and Nutritional Status of Older Persons  
Metabolic and Histological Changes in Obese Adult Female Rats Fed Liquid Protein Reducing Diets  
Nutritional Health of Adolescent Females  
Patterns of Food Intake and Nutritional Health of Girls  
Protein Utilization and Metabolism in Nutrition  
Vitamin C and Acute Physiological Responses to Cigarette Smoking

### Textile Safety

Selected Factors Affecting the Consumer Use Performance of Flame Retardant Fabrics

### Textile Utilization

Chemistry of Photo-degradation of Cotton Tentage Fabrics  
Consumer Expectations, Consumer Satisfaction, and Performance of Upholstery Fabrics

## HORTICULTURE

### Breeding

Breeding Improved Tomato and Pepper Varieties for the South  
Breeding Pickling Cucumbers for Resistance to Gummy Stem Blight and Cucumber Beetles  
Genetics and Breeding for Pest Resistance in Muskmelons and Watermelons  
Genetics and Breeding of Plums  
Southernpea Breeding and Nature of Resistance to Cowpea Curculio

### Management

Chemical Modification of Plant Growth Habit for Potted Plant Production  
Development and Evaluation of Rootstocks for Peach  
Factors Influencing Vegetative and Reproductive Development of Young Pecan Trees  
Nutritional, Cultural, and Varietal Improvements in Apples  
Regulation of Pistillate Flower Developments in Pecan  
Trickle Irrigation in Humid Regions

### Ornamentals and Landscape

#### Conservation

Economics of Producing and Marketing Woody Ornamentals in the South  
Identification and Control of Diseases on Ornamental Plants  
Nitrogen Requirements for Containerized Nursery Plants in Bark Growth Mixes

#### Soil Fertility

Soil Fertility and Fertilizer Requirements for Vegetable Crops

#### Utilization

New Foods from the Southernpea  
Quality Attributes of Selected Cultivars of Fruits and Vegetables

#### Varieties

Performance Trials of Commercially Important Vegetable Crops

## FISHERIES AND ALLIED AQUACULTURES

### Aquaculture

Aquaculture  
Culture Systems for Year-round Marketing of Fish from Watershed Ponds  
Freshwater Food Animals I  
Freshwater Food Animals II  
Freshwater Food Animals IV  
The Culture of Fish, Shellfish, and Aquatic Plants in a Closed System

### Aquatic Ecology

Stream and Impoundment Ecology

### Fish Biology

Ichthyology

### Fish Health

Cooperative Fish Parasite and Disease Study  
Freshwater Food Animals III

### Sportfish Management

Sportfish Management

### Water Quality Management

Management of Aquatic Plants for Sportfish Production in Ponds  
Pond Fertilization and Liming

## FORESTRY

### Disease Control

Ecology and Control of Fusiform Rust on Southern Pines

### Forest Genetics and Tree Improvement

Breeding and Culture of Christmas Trees  
Breeding Strategies for Genetic Improvement of Commercial Forest Trees in the South  
Genetics, Breeding, and Evaluation of Selected Forest Tree Species

### Forest Ecology

Evaluation of Site Potential for Yellow-poplar  
Site Index Curves for Use in the Hilly Coastal Plain

### Forest Measurements

Total Tree Volume and Weight Equations for Selected Tree Species in Alabama

### Forest Physiology and Nutrition

Growth and Nutrition Requirements of Selected Hardwoods  
Leaf Reflectance and Biological Processes of Trees as Affected by Environmental Conditions  
Reclamation of Drastically Disturbed Soils

### Forest Products and Technology

Evaluation of Structural Properties of Southern Yellow Pine Plywood  
Flakeboard and Composite Wood Panels from Small Dimension Southern Yellow Pine and Low Grade Hardwoods

### Forest Site Quality

Physiographic Classification of Southern Pine Forest Lands

### Forest Stand Improvement

Improved Methods of Thinning Southern Forests  
Variations in Height Over Age Curve of Young Loblolly Pine Plantations  
An In-depth Evaluation of Five Forest Harvesting Simulation Models for Use in South  
The Construction, Verification, and Validation of a Southern Forest Timber Harvesting Computer Simulation Model  
Mathematical and Computer Modeling for Optimizing Forest Harvesting and Wood Utilization  
Time and Production Studies of Feller-bunchers

### Resource Economics

Evaluation of Site Potential for Yellow-poplar  
Site Index Curves for Use in the Hilly Coastal Plain

## POULTRY SCIENCE

### Breeding

Artificial Insemination of Broiler Breeders  
Reproductive Performance of Artificially Inseminated Broiler Breeders Maintained in Cages

### Disease Control

Avian Coccidiosis: Immunological Resistance Against Clinical Infection  
Coccidia and Coccidiosis of Poultry  
Coccidiosis Study  
Developments of Adjuvants for Immunopotentiality of Inactivated Microbial Antigens for Poultry  
Diagnostic Services — Poultry  
Genetic Bases for Resistance to Avian Diseases  
Infection and Immunity in Poultry  
Relationship of Blood Pressure and Aortic Tissue Lipids and Atherosclerosis in Turkeys  
Susceptibility of Eimeria Species to Coccidiostats

### Environment

Eggshell Quality of Domestic Fowl  
Environmental Influences on Poultry  
Utilization of Solar Energy in Poultry Production

## ZOOLOGY-ENTOMOLOGY

### Ecology

Ecological Impacts of Wading Birds on Aquatic Environment  
Natural History of the Alabama Red-bellied Turtle

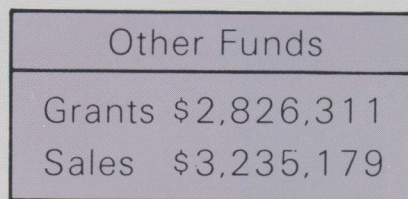
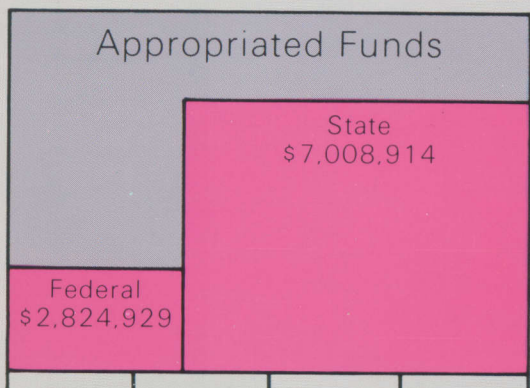
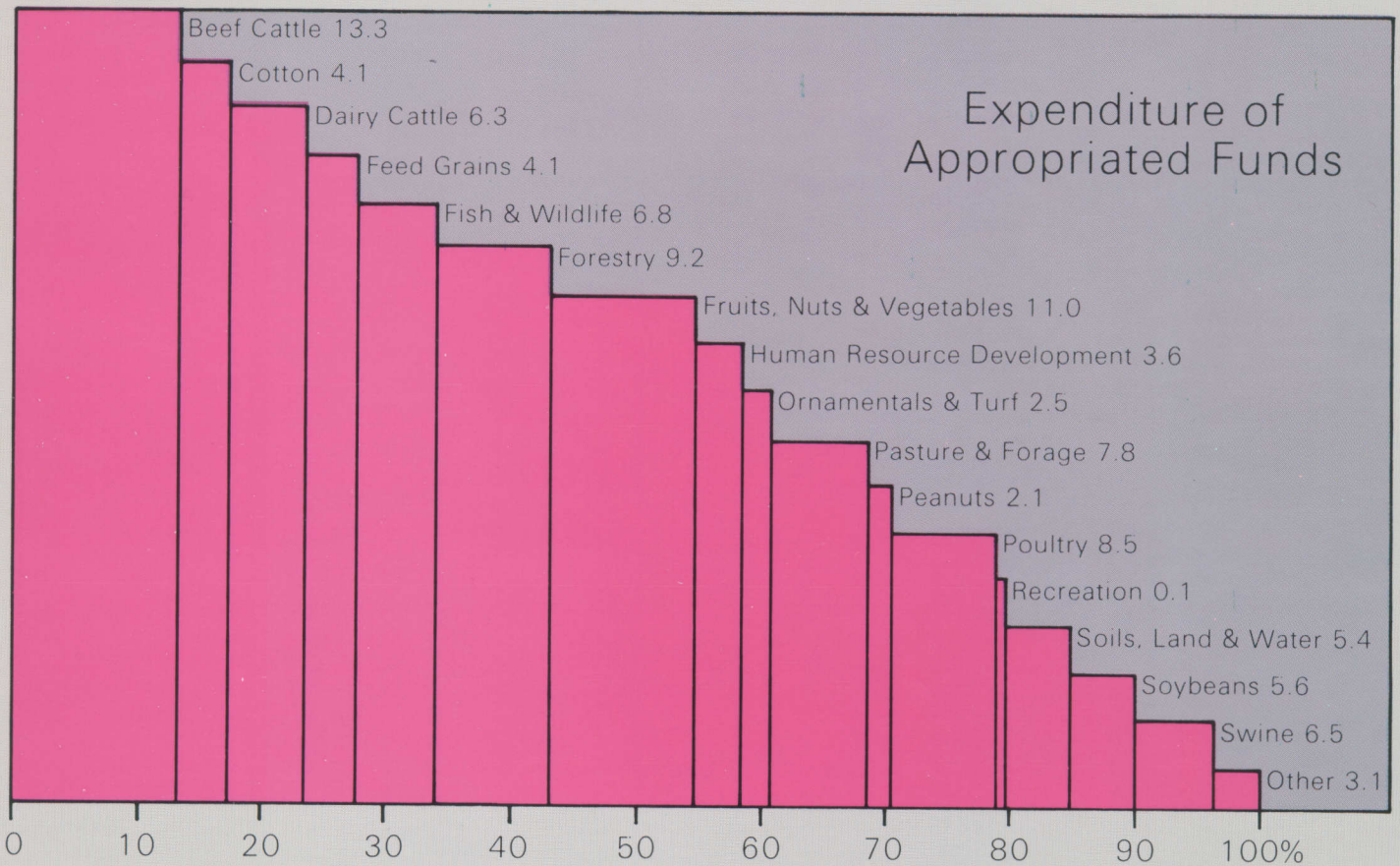
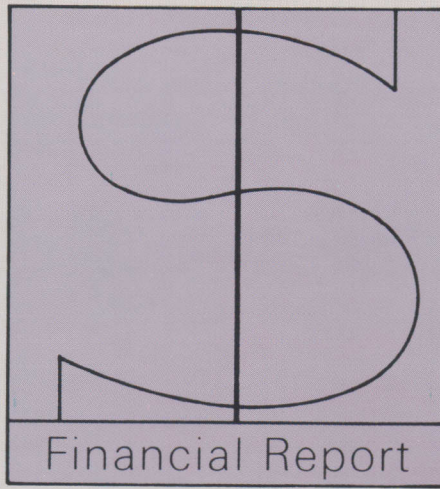
### Miscellaneous

Auburn University Entomological Museum  
Endocrine and Muscle Relationships in Swine and Cattle  
Herpetology Museum  
Reproductive Physiology of Farm Animals  
Structure and Function of Chemical Messengers

### Pest Control

An Integrated System for the Suppression of Boll Weevil  
Biological Control of Selected Arthropod Pests  
Biology and Control of Arthropod Pests  
Biology and Control of Arthropod Pests of Pecans  
Biology and Control of Arthropod Pests of Woody Ornamental Plants in Alabama  
Biology and Control of Insect Pests of Peanuts  
Biology, Ecology, and Control of Forest and Shade Tree Insects  
Bionomics and Control of Arthropod Pests of Corn, Sorghum, and Small Grains  
Bionomics and Control of the Face Fly and Other Diptera  
Bionomics and Control of the Pecan Weevil  
Biosystematics of Scale Insects of Alabama  
Control Tactics and Management Systems for Arthropod Pests of Soybeans  
Ecology and Management of *Heliothis* spp. on Cotton, Corn, Soybeans, and Other Host Plants  
Southern Pine Beetle  
Vegetable Insects Research  
Wildlife Management  
Ecological Studies of Wild Turkeys  
Furbearer and Mammalian Predator Studies  
General Wildlife Studies  
Reproductive Physiology of the Wild Turkey  
Woodcock Studies

**BACK COVER: Farmers and professional agricultural workers are able to see research in progress during field days at the outlying units.**



**TOTAL FUNDS \$15,895,333**

0 25 50 75 100%



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