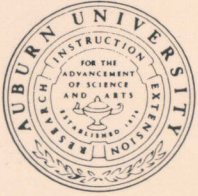




A U B U R N U N I V E R S I T Y



ALABAMA AGRICULTURAL EXPERIMENT STATION



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COVER STORY: *The nursery industry is one of Alabama's little known "big businesses". Throughout the decade of the 1980's, the industry showed slow, but steady growth. Research at the Alabama Agricultural Experiment Station has played a key role in the development and growth of the nursery industry in the State. Much of the Experiment Station nursery research is conducted at the Ornamental Horticulture Substation in Mobile, site of an annual Nursery Field Day. The cover photo shows Auburn researchers at the 1989 Field Day explaining tests designed to determine the type and amount of damage done to nursery crops by various insects.*

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F O R E W O R D

World agricultural and forestry problems are linked so closely that an upset in one locality may be felt on the other side of the globe. The hazards of drought, flood, cold, insects, diseases, and other elements of nature impact global production of food and fiber. Global concerns in turn impact the agricultural and forest economy of Alabama.

In the past, farmers and farm families may have been culturally distinctive, but improvements in communication and transportation have broken down many of our cultural barriers. Distinctions between the farm and non-farm segments of the community are becoming nonexistent. Food and fiber production are influenced by a multiplicity of factors that were not present a few years past. This has caused a decrease in "full-time" farmers and resulted in more part-time farmers. Irrespective, one factor that has remained constant is the need for profitability.

Today, producers of food and fiber are confronted with rules and



Lowell T. Frobish, Director AAES

regulations from all levels of government and with a society that demands an inexpensive, yet safe, food supply. Some public action groups already advocate the use of agricultural chemicals, synthetic fertilizers, growth promotants, to name a few, not be reduced, but cease. The push for a return to the use of draft horses, organic fertilizers, and natural pest control is gaining momentum. Most people have heard such terms as LISA (Low Input Sustainable Agriculture), Alternative Agriculture, Regenerative Agriculture, and other programs mentioned as substitutes for intensive production practices that require the use of pesticides and other valuable farm chemicals.

While few would argue that reduced use of chemicals would be beneficial to man and the environment, there must be a balance. Without farm chemicals, we could not produce the plentiful, safe food supply that Americans demand — not with the current distribution of farm and non-farm labor. Finding

practical uses of biological, or naturally occurring compounds to fight pests and combat drought, freezes, and myriad production restraints that farmers face everyday is an ongoing challenge for Experiment Station research.

The Alabama Agricultural Experiment Station is concerned about the environment and the conservation and preservation of the State's natural resources. Our scientists are environmentalists. Their research emphasizes finding alternatives to many of today's production practices. A balance between natural and chemical control of production pests is of major concern. This report summarizes our research effort that is of benefit to all Alabamians. Greater emphasis is given to defining alternative production systems. Your input and interest in our programs are appreciated. You, the consumer, are an important part of our team. Our research programs are not designed for either large or small producers, but are size neutral. They benefit us all!

INTRODUCTION

Much of the research conducted by the Alabama Agricultural Experiment Station is highly visible and provides immediate technological benefit to producers. Other work, known in the scientific community as basic research, is more behind the scenes. While this work may not be immediately beneficial to producers, it may provide the stepping stone for the next generation of new technology and benefit future generations of Alabamians.

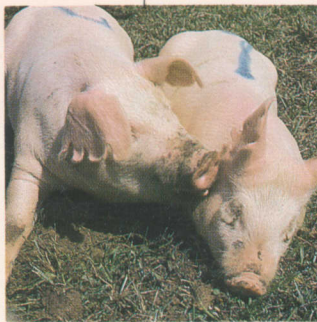
Biotechnology and Genetics are "hot" areas of research at universities nationwide. Last year the Experiment Station made giant strides in developing biotechnology programs. Experiment Station research with transgenic fish, which contain genes from other fish, brought journalists from as far away as Germany and Finland to report on this new technology. Development of this technology opens the way for inserting genes to improve resistance to disease and reduce susceptibility to a multitude of stress-related production problems.

In related work, poultry researchers recently found that a specific gene functions differently in different genetic backgrounds. Large differential effects of genes designated B1 and B2 on Marek's disease (MD) in Leghorns were absent in broilers. B1 genes were resistant to MD and B2 genes were susceptible to it. In Leghorn-broiler crosses, the B1 progeny had one-half of

the mortality from the disease and twice the reproductive efficiency of their B2 siblings, indicating the effects of a gene are highly dependent upon the other genes present. In the Auburn test, the regulation of the expression of an individual gene was as important as its individual structure.

Genetics research by plant scientists is underway to identify and replicate DNA clones from soybean mitochondria. Results of these studies will provide a basic understanding of DNA replication processes in plant mitochondria, and may help researchers provide a basis for developing cloning vectors capable of introducing foreign traits into plants.

In a multi-disciplinary study, researchers have completed the first step in genetically improving a mycorrhizal fungus that benefits root systems of trees. These mycorrhizal fungi help plants absorb water and nutrients and to resist damage from root diseases, pollution, and other stress factors. Researchers intend to construct strains of the fungus with an improved ability to relieve plant stress. Improvements in the efficiency of these fungi to help produce healthier seedlings could provide an economic



Animal research is geared to producing a safer food supply for consumers and greater profit for producers.



Wildlife researchers are helping develop both the recreational and business aspects of hunting and fishing in the State.



Auburn researchers release channel catfish with growth hormone genes from coldwater species into a specially protected pond near the Auburn campus.



Biotechnology and genetics research have dramatic promise for future generations of Alabamians.

boost to the \$63 billion a year forest industry in the Southeast.

Much of the genetics research conducted by the Experiment Station will benefit from the opening of the Auburn University Cell Science Center. It is comprised of laboratory units for research on monoclonal antibodies, fermentation, and plant tissue culture. Specifically, research underway on hormone-induced gene expression and protein secretion in animal cells may have broad application in animal husbandry and human health and nutrition.

Another project underway at the Center deals with molecular biology of nitrogen fixation, which has direct application to plant biology and agricultural crops. The new tissue culture laboratories at the Center support work to develop a cold-hardy eucalyptus tree for use by the Southern pulp and paper industry.

While some of these high tech results will be of immediate benefit to producers, others are likely to be more fully utilized in the future. However, the bulk of Experiment Station research is geared to help today and tomorrow. With such a diverse research program, it is impossible to report on each endeavor. The following pages are dedicated to the highlights of some of the research results by the Alabama Agricultural Experiment Station in 1989.



Alabama is fortunate to have important beef cattle, dairy, swine, poultry, and catfish production centers scattered throughout the State. However, this diversity of food animal production requires a diverse research program to provide the technological base for continued growth. Not only must Experiment Station researchers work with a diversity of animals, they must likewise work in a number of production areas.

Much of the animal research involves reproduction, nutrition, and physiology that provides the technology for producers to advance to the next level of production. For example, researchers recently developed an assay method that, when combined with chemical separation technology already available, will allow them to more closely determine the biochemical nature of reproductive tissue of heifers. Data from the tests indicate that factors produced by the uterus

and placenta may influence the length of time of postpartum anestrous in beef cattle.

Researchers are currently studying the role of 3-ribosyluric acid in protecting beef cattle from nitrite poisoning. Indications are that oxidation occurs in two phases and the addition of 3-ribosyluric acid increases oxidation time from about 10 minutes to about 3 hours. By understanding the mechanisms by which 3-ribosyluric acid works, researchers are hoping to develop more potent anti-oxidants.

Catfish production continues to grow in Alabama, but disease remains a production obstacle. *Edwardsiella ictaluri* (ESC) is a serious disease problem of catfish that producers overcome by adding antibiotics to fish feed. Auburn researchers are currently working on getting Sarafloxacin, a new quinoline compound, approved for use on farmed fish. It has several advantages over other antibiotics for fish. It can be incorporated into

Beef cattle and sheep usually don't mix, but recent research indicates the "woollies" may become a good cash crop for Alabama livestock producers.

floating pellets because of its heat stability, it presents no palatability problems, it is highly effective against ESC, and it has a low tendency to cause antibiotic resistance in bacteria.

Poultry remains a dominant food animal industry in the State, with new production pushing Alabama into second place, behind Arkansas, in broiler production. The continued growth and technological advance in the industry provide many research challenges. Similar challenges are being met by dairy and swine researchers in the Experiment Station.

Licorice-like Spray Improves Dairy Production

Cows placed in new management groups based on nutritional considerations usually go through a period of 1-2 days of increased

aggression during which a new social order is established. Masking individual odors by spraying anise oil, an olfactory nerve stimulant that smells like licorice, on all cows in a group resulted in decreased fighting in cows placed in new management groups. Masking odors with anise oil also eliminated the drop in milk production often observed in cows placed in new groups.

New Drug More Effective on Coccidiosis-Caused Scours

Coccidiosis is one cause of scours in newborn baby pigs. It has been previously reported by Experiment Station researchers that the drug Amprolium is beneficial in controlling scours caused by this organism. However, a new drug, Toltrazuril, was more effective than Amprolin in tests last year.

Treatment of coccidiosis-infected pigs with toltrazuril at the dosage of 5 or 10 mg per kg of body weight resulted in these pigs gaining weight comparable to or better than the noninfected controls. Toltrazuril-treated pigs excreted few or no oocysts in the feces, reducing the possibility of reinfection. If approved by the Federal Drug Administration for use in swine, the drug should provide a better control for one cause of scours in baby pigs.

Reduced Light Improves Rooster Reproductivity

Light plays an important role in regulation of reproduction in birds, including chickens. Most commercial light schedules are designed to stimulate egg production at an appropriate age. In natural mating systems, roosters are considered a necessary evil required for fertility of the egg and are exposed to long photoschedules used for hens.

Flock fertility generally declines after roosters reach 48 weeks of age, and this reduction has been associated with excessive body weight or fat, leg problems, decreased shell strength, diminished mating activity, or poor semen quality. Experiment Station research has shown that long light schedules may reduce semen pro-

duction, spermatozoa quality, and possibly contribute to reduced fertility.

Age at sexual maturity (ejaculation of first spermatozoa) was earliest for males given 8 hours of light. Body weight of the 8-hour group was lower than the other treatments, suggesting increased physical activity in this group. Testes weights, percent males producing semen, semen weight per ejaculate, and percent live spermatozoa were greater from roosters maintained on 8 or fewer hours of light compared to the groups on 16 or 24 hours of light.

Phosphorus Source Affects Poultry Processing Problems

Leg problems continue to be a concern for poultry producers in Alabama and across the country. Chickens that are fed nutritionally balanced diets and raised under optimum management conditions, and which appear normal, often end up with broken legs and wings in the processing plants. The end result is condemnation or downgrading of poultry meat, which costs poultrymen and ultimately consumers.

Experiment Station research indicates that the source of phosphorus in the diet of chickens may be the cause of some leg problems. In poultry diets, calcium and phosphorus can be supplied from either organic or inorganic sources. Bone meal is an organic source, and its phosphorus has been considered to be 100 percent available to chickens. However, there are reports of variations ranging from 5 percent to 30 percent in phosphorus availability from bone meal. Because of these variations, errors may be made when bone meal is included in diets for meat type chickens.

In the Auburn research, source and particle size of bone meal were evaluated as factors influencing phosphorus availability. Data were com-

pared with those obtained using dicalcium phosphate, an inorganic phosphorus supplement of excellent phosphorus availability that is commonly used in poultry diets, as the standard.

Results indicated that there was no difference in phosphorus availability among bone meal sources. However, phosphorus from the different bone meal sources was 6-12 percent less available than that from dicalcium phosphate. This means that chickens fed organic phosphorus supplements might be receiving marginal levels of phosphorus, if availability values of 100 percent are used. The degree of deficiency would be dependent upon the percent of total dietary phosphorus supplied by the organic sources.

This research indicates that phosphorus availability values of 90-95 percent, instead of 100 percent, may be used in diets containing organic phosphorus sources to reduce otherwise unexplained leg problems in chickens.

Portable X-Ray Valuable in Poultry Disease Diagnosis

Tibial dyschondroplasia (TD) is a skeletal abnormality in poultry that costs the industry millions of dollars annually. While the exact source of TD is unknown, Experiment Station researchers have developed a non-lethal technique for diagnosis.

A major obstacle in the past has been diagnostics, because the diagnosis either required killing suspect birds or employing immobile X-ray equipment. The new technique developed at Auburn

University employs a hand-held gun (Lixiscope), that can easily and accurately diagnose the condition, thereby allowing more precise genetic, nutrition, and management studies as they relate to TD. This technique has been used to successfully diagnose the occurrence of TD in several thousand 3- to



Poultry disease and nutrition studies continue to play a role in the continued growth of the poultry industry in the State.

7-week-old broiler-type chicks in experiments at Auburn.

New Vitamin C Source for Fish Feeds

While most animals don't require vitamin C in their diet, fish are extremely sensitive to a deficiency. Without vitamin C, fish show reduced growth rate, physical deformities (crooked backs, etc.), slow wound healing, and reduced resistance to infections, environmental contaminants, and other stresses.

L-ascorbic acid is the vitamin C source used in commercial fish feeds. It is sensitive to oxidation, and heat and moisture associated with feed processing destroy 40 to 60 percent of the amount put into the feed. Also, its half-life (time required for 50 percent to be lost) in fish feeds during storage is less than 90 days. Because of the large losses of ascorbic acid during processing and storage, new sources of vitamin C are needed for use in aquaculture feeds.

Phosphate and sulfate derivatives of ascorbic acid, which are relatively stable against oxidative deterioration, were examined in Experiment Station research as potential sources of vitamin C for fish feeds. Ascorbic acid phosphate (L-ascorbyl-phosphate Mg), and ascorbic acid sulfate (L-ascorbyl-2-sulfate) were compared with L-ascorbic acid for vitamin C activity for channel catfish. Each source of vitamin C was fed at four levels in purified diets under controlled laboratory conditions.

Fish fed no ascorbic acid (control) grew poorly. Those fed ascorbic acid sulfate also grew poorly and although growth improved as the dietary level increased, it never reached the growth rate of the fish fed L-ascorbic acid. Growth rate of fish fed ascorbic acid phosphate was equal to that of the fish fed L-ascorbic acid.



Producers are sure to benefit from development of feeds more efficient in delivering the Vitamin C needs of catfish.

This was true even at the lowest level fed, which is near the lower limit of the channel catfish's vitamin C requirements.

There were no deformities in the fish fed any of the dietary levels of L-ascorbic acid or ascorbic acid phosphate. However, there was over 50 percent deformed fish, mainly crooked backs, among fish fed the control diet. Only the highest dose of ascorbic acid sulfate (31 mg per kg) prevented deformities in the fish.

The results show that ascorbic acid phosphate is equal to L-ascorbic acid in meeting the vitamin C requirements of channel catfish, but that ascorbic acid sulfate has less vitamin C activity.

During extrusion processing of catfish feed, only 10 to 20 percent of ascorbic acid phosphate was lost, while 50 to 60 percent of L-ascorbic acid was lost. Because of increased stability during processing and high vitamin C activity, ascorbic acid phosphate will likely be a major source of vitamin C in aquaculture feeds in the future. This will allow more precise supplementation of fish feeds with vitamin C, providing a cost savings and increased assurance that the feed is sufficient in vitamin C.

Infected Fescue Reduces Heifer Pregnancy Rate

Previous Experiment Station research conducted at the Black Belt and Tennessee Valley substations showed that pregnancy rates in heifers grazing fungus-infected tall fescue were reduced 60 percent com-

pared to heifers grazing noninfected fescue. The differences were even more dramatic when the heifers were rebred following calving. Only 33 percent of the heifers grazing infected fescue became pregnant again, compared to 93 percent of those grazing noninfected fescue.

Current research at the E.V. Smith Re-

search Center is being conducted with an overall objective to learn why heifers did not become pregnant. A study in which changes in blood hormone patterns were measured showed that heifers grazing infected fescue had normal reproductive cycles.

An embryo transfer study was conducted in which embryos flushed from cows not grazing fescue were transferred to heifers grazing either infected or noninfected fescue. Only 31 percent of the recipient heifers grazing infected fescue had successful pregnancies compared to 73 percent of those grazing noninfected fescue.

These results indicate that toxins in the fescue are altering the uterine environment so a successful pregnancy cannot be maintained.

Catfish Models Provide Marketing Support

Two new computer models were developed by Auburn researchers to benefit the State's growing catfish industry. A bioeconomic model was developed to help producers predict fish growth. The model uses water temperature, body weight of the fish, feeding rates, and diet composition as parameters for fish growth. Output from the fish growth model was used to generate a production function for five decision variables: stocking date, stocking weight, dietary protein percent, feeding rate, and crop length. Economic tradeoffs are demonstrated by the model.

An econometric model for catfish was developed that takes into account several unique features of this successful, rapidly growing industry. These include: an imperfectly competitive processing sector, rapid industry growth, a marketing problem known as off-flavor, and industry funded marketing efforts. The model contains three structural equations: a farm-level supply equation, a processor price-markup equation, and a wholesale-level demand equation and a farm level equation.



Bacterial diseases are a major yield-robbing problem for many crops grown in Alabama. Not only does this group of diseases reduce productivity, but growers spend millions of dollars annually to protect their crop from them. Last year Experiment Station research made a major breakthrough in understanding bacterial diseases of plants. Researchers used a sophisticated cloning procedure to produce bioluminescent bacteria that can be observed using light sensitive cameras. This allows scientists to record kinetics and patterns of plant colonization by bacteria.

Biotechnological efforts are also well underway to provide alternative methods to control insects. One such study involves feeding high levels of copper, cobalt, manganese, lead, magnesium, and

calcium to a species of insects known to feed on vegetable crops. Some vegetables are known to be hyperaccumulators of heavy metals, and by adding the metals at levels toxic to insects, researchers sought to kill the insects without harming the plants. Though results are preliminary, cobalt appears to have the highest toxicity and calcium, magnesium, and manganese the lowest toxicity.

Spiroplasmas are spiral-shaped, wall-less bacteria that cause corn stunt, citrus stubborn disease, and spiroplasmosis of honeybees. Researchers have developed a cell culture system for one of the primary host plants of the bacteria, allowing them to maintain cultures, whole cell suspensions, and protoplasts of the virus. Using spiroplasma strains representing insect and plant pathogens and

Production of agronomic crops, like peanuts, will benefit in the future from biotechnology being developed currently by Auburn researchers.

saprophytes, researchers are currently studying growth and physiological responses of plant cells during spiroplasma infections and similar responses of spiroplasmas interacting with plant cells.

Rhodobacter sphaeroides, a bacterium essential to photosynthesis, and atrazine, a popular herbicide used on a wide range of crops, do not mix, according to AAES studies. Though it has been known for many years that atrazine kills weeds by inhibiting photosynthesis, the exact mode of action has only recently been determined. Auburn researchers recently found that certain polypeptides exist in strains of *R. sphaeroides* resistant to atra-

zine. Further exploration of these relationships could unlock the secret of resistance to pesticides by various plants and make possible a whole new era of biological control.

Contamination of food and feeds by toxin-producing molds leads to substantial crop losses, especially in corn and peanuts. Auburn researchers recently developed an assay using ultraviolet light to measure fluorescence of the aflatoxin produced by the fungus grown on coconut-based medium. While the assay is not practical for field detection of aflatoxin, it has potential as an assay in the study of the genetic basis for aflatoxin synthesis and in the screening of enzymes that selectively degrade the toxin. Such studies may lead to biocontrol in the field for the toxin.

Utilizing waste products is an ongoing research objective in several Experiment Station research projects. Researchers recently produced small amounts of ethanol, which can be used for fuel alcohol, from glucosamine, a product of chitin found in waste shellfish. The microorganisms *Pachysolen tanophilus*, a yeast, and *Zymomonas mobilis*, a bacterium, were grown on the chitin-containing shellfish to produce the alcohol. Using microorganisms to process organic waste into protein and fuel alcohol could be of direct economic value while also contributing materially to environmental quality via recycling organic waste into valuable products.

While laboratory work promises great things for the future, a vigorous field research program at the Experiment Station is geared to more immediately benefit growers and producers.

New Viral Disease Found in Alabama Wheat

Soil-borne wheat mosaic virus (WSBMV) was found in Autauga County in the spring of 1989, representing the first known record of this disease in the State. This disease is common in the Midwest and is controlled by growing resistant soft red winter wheat varieties.

Yield of susceptible varieties can be reduced by up to 30 percent. Identification of this disease suggests that selection of WSBMV resistant varieties may be important in Alabama.

The disease symptoms appear as green to prominent-yellow mosaic leaf symptoms on stunted plants. Diseased wheat plants are typically in lower or poorly drained areas of production.

Soil-borne wheat mosaic virus is an interesting disease in that the causal virus is one of only a few that are spread in nature by a soil-inhabiting fungus that has a water mobile zoospore. Future research will focus on determining the distribution and importance of soil-borne wheat mosaic virus in the wheat crop in Alabama.

New Peanut Fungicides Improve Quality, Profit

The effect of fungicides applied to foliage for peanut leafspot and white mold control on fungi infecting seeds and on aflatoxin content has been investigated for the past two crop seasons. A single application of the sterol biosynthesis inhibiting fungicides, diniconazole, terbutrazole, and flutolanil, resulted in reduced fungal seed infection, reduced aflatoxin content, and increased quality. Quality increases realized through a reduction in seed infection by fungi have resulted in a calculated \$700 per acre net increase. Aflatoxin levels were reduced 11-33 percent.

Accent Herbicide Effective For Corn Weed Control

Rhizome johnsongrass is a competitive and persistent weed species for corn producers. It also serves as a host for maize chlorotic dwarf and maize dwarf mosaic viruses that cause substantial yield losses annually in Alabama. Effective means of controlling this weed pest with herbicides would improve the flexibility and effi-



Improving herbicide timing and application will help growers be more efficient and benefit the environment as well.

ciency of corn production in Alabama.

Experiments were initiated at four sites in 1988 and 1989 to evaluate rhizome johnsongrass control in corn with Accent herbicide. Control of broadleaf signalgrass and Texas panicum was also evaluated.

Summary of data shows good to excellent control of rhizome johnsongrass, broadleaf signalgrass, and Texas panicum with single and double postemergence applications of Accent herbicide. Controlling a heavy infestation of rhizome johnsongrass and broadleaf signalgrass population in north-west Alabama in 1989 increased corn yield 60 bushels per acre over the untreated control.

Accent also suppressed growth of pigweed and morningglory species. In an experiment at the Plant Breeding Unit at Tallassee, where pigweed, annual morningglory, large crabgrass, and goosegrass predominated, a double application of Accent combined with a single cultivation increased corn yield 61 bushels per acre over the untreated control.

Good to excellent control of Texas panicum was achieved at the Wiregrass Substation in Headland in 1989 with a single application of Accent applied when the grass had four to six leaves. Corn yield was improved 36 bushels per acre over the untreated control.

Tomato Spotted Wilt Virus A Threat to Alabama Crops

Tomato spotted wilt virus (TSWV) is vectored by several species of thrips and has caused losses of over 50 percent in peanut and tomato production in other states. Since its first identification in Alabama in 1986, annual surveys have found the disease to be widespread, but minor in severity, in peanut producing counties. The incidence and severity by TSWV was higher in 1989 than any

previous year and yield losses in individual plantings were 10 percent or more, but yield losses generally have been less than 1 percent in individual fields.

Control of the thrips vector with recommended insecticide regimes has not resulted in a significant reduction in TSWV spread or incidence in peanuts. In 1989 the incidence of TSWV in the varieties Southern Runner and GK-7 was lower than in Florunner, the most commonly grown variety in Alabama.

Soil Solarization Effective in Controlling Weeds

Soil solarization is the process of using clear polyethylene plastic film during summer fallow periods to capture solar energy and produce soil temperatures high enough to control many annual weeds and kill some disease-causing organisms. Research at the Experiment Station indicates that soil solarization in combination with chicken manure effectively controlled morningglory and sicklepod.

The solarized chicken manure-soil mix provided 99 percent control of both weed species after a 4-week solarization period. These results were comparable to those where weeds were grown in the absence of chicken manure, but under the same solarization treatments. Unsolarized chicken manure-soil mix provided 41 percent and 49 percent control of morningglory and sicklepod, respectively.

Temperatures recorded at 6-inch soil depths in solarized and unsolarized plots with chicken manure averaged 25°F and 10°F higher, respectively, than in plots with no chicken manure or solarization exposure. Researchers reported that high temperatures are probably responsible for weed control.

This method should not be regarded as a universal method of weed control but rather an additional method that, used correctly, has many advantages. It is safe, non-chemical, inexpensive, leaves no phytotoxic (plant injuring) residues, and is simple to apply.

Frost-Protecting Sprays Increase Peach Yield

Damage or complete loss of Alabama's peach crop due to late spring frost in recent years has been a major problem for growers. Research using growth regulators to delay bloom past the danger of spring frost and enhance cold bud hardiness has produced promising results. The research was initiated in the fall to determine the effect of fall application of gibberellic acid (GA_3) on delaying bloom of peach trees in the spring as a means of frost protection.

In the spring of 1987, trees were in full bloom by March 31 and a frost with temperatures below 25 degrees F occurred on April 1 and April 4 with considerable flower and young fruit damage evident after each frost. No frost injury occurred in the spring of 1989.

In the spring of 1987 and 1989, GA_3 treatments of 50 and 100 p.p.m. delayed bloom, whereas the 10 p.p.m. GA_3 treatment bloomed at the same time as the nontreated trees. GA_3 treatments resulted in a greater percent of the flowers setting fruit and required more hand thinning. Yield was increased about 30 percent in 1987 and about 40 percent in 1989 by the 10 p.p.m. GA_3 treatment. Yield was increased each year by the 50 and 100 p.p.m. treatment, but not as much as with the 10 p.p.m. treatment. Fruit from the nontreated and the 10 p.p.m. treated trees ripened at the same time, however fruit ripening was delayed by the 50-100 p.p.m. GA_3 treatments. Fruit size was not affected by the different GA_3 treatments.

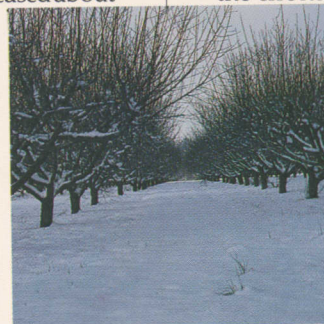
Irrigation Studies Improve Efficiency of Water Use

Researchers evaluated several design aspects of small acreage hard hose traveler (SAT's) irrigation systems. One study related to the method of testing travelers for water application uniformity. Two water supply methods, (constant inlet pressure and constant inlet flowrate) had been proposed as part of an ASAE standard. The field study and analysis identified differences that would result from the two test methods. Flowrate, pressure, and resulting depth of application were shown to be different, however, these differences had little effect on measures of application uniformity.

In another study, variations in energy requirements were determined for a traveler as its hose was coiled onto the reel. Hose coiling had the effect of increasing pressure losses in the hose and, thus, increasing energy requirements for the machine. The major result of this study was the determination of a bend factor which could be used to predict the additional energy losses.

During 1989, instrumented runoff plants were established to study the effects of soil compaction and

reservoir tillage on water utilization. Both natural rainfall and irrigation were evaluated in replicated plots of cotton. Irrigation consisted of a LEPA system (Low Energy, Precision Application) mounted on a boom traveler. The reservoir tillage concept includes ripping in the furrow (1 foot) and then adding below-surface reservoirs into the ripped zone. Preliminary results have shown a significant reduction in surface runoff with the utilization of reservoirs and reduced soil compaction.



Protection of plants against the weather is an ongoing goal of Experiment Station research.



Wise use of water resources will be even more essential for farmers of the future.



The Southeast has a long tradition of leadership in the forest industry, but recent trends indicate the region will play an even more significant role in the next century. Some forecasters are predicting over 60 percent of the nation's forest products will come from the Southeast by the year 2000. To help meet this demand, forestry researchers are conducting tests that run the gamut from seed production to finished products.

Forestry research, which includes many multi-disciplinary projects, is a classic example of the high tech "new" working well with the more down to earth "old." Computer models are bringing computers into the planning of timber harvest and forest product manufacturing. On the other hand, herbicide research to improve seedling production and studies of site evaluation for improving the results of planting provide landowners and commercial foresters with vital production technology.

Herbicide Application Improves Seedling Survival and Growth

Recent studies indicate early pine seedling growth is markedly increased when competing grasses and herbaceous vegetation are killed. Consequently, many forest landowners are applying herbicides for herbaceous weed control soon after planting pine seedlings. Though it is generally assumed that soil moisture is the mechanism which relates reduced herbaceous competition to increased pine seedling growth, only limited information is available to document relationships among herbicide applications, nonpine

The South will produce an even greater percentage of the country's timber in the next century, and research is geared to helping landowners meet this increased demand.

vegetation, soil moisture, and pine seedling growth.

In an Experiment Station test, Oust herbicide was applied to an old abandoned pasture at varied rates in order to obtain a range of herbaceous/grass cover in established study plots. Loblolly pine seedlings were planted and soil moisture levels were monitored for two growing seasons.

Lower levels of competing herbaceous vegetation achieved by herbicide application resulted in increased 2-year pine seedling survival, height growth, and diameter growth. The relationship between nonpine live cover and pine growth was inverse and linear within the range of herbaceous cover achieved. This relationship was clearest and strongest for seedling diameter.

Broadcast applications of Oust at 4 ounces per acre achieved optimum results from competition cover reduction and pine seedling survival and growth on this site. An 8-ounce rate did not produce improvement over the 4-ounce level. However, the remaining live cover on plots treated with 4 ounces averaged about 35 percent. This suggests that a more effective herbicide application might have improved pine survival and growth.

Soil moisture levels were clearly different between high and low cover levels for the growing season immediately after cover was reduced. The inverse quantitative relationship between the amount of live cover and measured soil moisture was weak.

Significant correlations were found between soil moisture and 2-year seedling survival and 1-year seedling diameter growth. It appeared that soil moisture utilization by the pine seedlings themselves weakened the measured relationships.

Young Pines Can Produce High Quality Timber

It has been documented that within a few years, 50 percent of the softwood forests in the South will consist of plantation trees, and by the year 2000, pine plantations will

supply more than half of the softwood timber. Southern pine plantations, particularly loblolly and slash, of ages between 20 and 30 years contain from 30 percent to 60 percent juvenile wood. It is weaker and less stiff, with greater longitudinal shrinkage than mature wood. Plantation trees of these ages also have numerous branches that become knots when logs are sawn, producing lumber of lower grades.

An earlier study compared the lumber yield recovery from 20- and 50-year-old slash pine plantations with approximately the same diameter breast height (dbh). Initial spacing of the 20-year-old plantation was 12 feet x 12 feet and that of the 50-year-old was 6 feet x 6 feet. The site index for both stands was 105 feet at 50 years. The results indicated that the total lumber volume recovery of the 20-year-old trees was 39 percent of the lumber recovered from the 50-year-old trees.

The same study found that the strength properties of lumber from the 20-year-old plantation was only 54 percent the strength of lumber from the 50-year-old trees. All tested lumber from the 50-year-old trees met the required structure standards for the grade. A significant percentage of the lumber from the 20-year-old trees did not meet the required standards for the grade.

A similar Experiment Station study concerned lumber yield recovery and lumber grade recovery from a 27-year-old plantation of slash pine in southwest Alabama. The plantation was established on a 6 foot x 6 foot spacing in a location with a site index 90 feet at 50 years.

Lumber from the 27-year-old slash plantation was of high quality with exceptional high lumber grade distribution, higher than that of the 50-year-old trees. The grades of all lumber from the 27-year-old stand were 43 percent Number 1, 49 percent Number 2, and 8 percent Number 3. All obtained lumber met the required standards for the grade.

Results of the Auburn study indicate that relatively young

(27-year-old) slash pine plantations with original spacing 6 feet by 6 feet in a good site can produce exceptionally high quality and valuable lumber. Additional studies are underway by the AAES to investigate lumber yield and properties of loblolly plantations of different initial spacings, thinnings, site indexes, and ages.

New Fungicides, Site Keys to Seedling Disease Control

Pine seedling mortality is a major problem on many sites being converted from agronomic crops to forest plantations under the Conservation Reserve Program. Agricultural Experiment Station research has demonstrated that mortality on these sites often is associated with decortication of roots and stems by insects, followed by invasion by fungi. Researchers found mortality in such cases is more severe on sites where a plowpan has been developed, and current recommendations call for the plowpan to be broken by a ripper blade prior to planting tree seedlings.

One of the disease problems of nursery bed pine seedlings is caused by a binucleate *Rhizoctonia* sp. Experiment Station research has shown that SN 84364, an experimental fungicide, controls the disease. Studies currently are being conducted to define most effective rates and spray schedules. An important observation made during the course of these studies is that seedlings in fall-sown nursery beds are less likely to become diseased than those in spring-sown beds.

Nitrogen Nutrition Level Important to Seedling Growth

Improving the growth potential of artificially regenerated lands in Alabama is the goal of nursery culture and stand establishment research. Analysis of tree growth and development demonstrates that small increases in seedling size at the time of planting can have a significant impact on plantation yield. Responses from a number of experiments show that average survival can be increased by 2 to 10

percent and average yields by 1.5 to 5 cords per acre for each millimeter increase in seedling diameter at the time of planting.

Current research has focused upon the mechanisms regulating these responses. Experiments at Auburn have demonstrated how the total quantity of needles per seedling, the photosynthetic efficiency as affected by nitrogen nutrition, and the development of branches can account for the observed responses. The amount of new root growth, which is essential for initial survival, was shown to be closely related to current photosynthetic capacity of the seedlings, particularly the amount of foliage, and not the quantity of carbohydrate reserves in the tissue as previously thought.

Studies also show that the observed increases in growth associated with larger diameter seedlings are closely associated with differences in initial foliage biomass and subsequent branch formation, which permits greater light interception. Experiments focusing upon the effects of nitrogen nutrition on plantation development indicate that improvements in growth and photosynthetic efficiency occur even at nutritional levels which are supra-optimal for growth in the nursery. This effect may arise from increased amino acid and protein synthesis and from increased retranslocation of nitrogen from older needles to current growth.

Forest Growth Studied From NASA Satellite

Auburn researchers working in cooperation with scientists from NASA's Stennis Space Center in Bay St. Louis, Mississippi, used a visible and infrared scanning radiometer to quantify changes in light reflected from the foliage of plants. Both the quantity and quality of light reflected by foliage is thought to be strongly controlled by foliar anatomy and the chemical constituents of the foliage. In the past, scientists have suggested that since various stresses may cause unique changes

to the anatomy and chemistry of foliage, reflectance measurements (if precise enough to reveal sufficient detail) may be used to monitor the health of our forests from satellites, or to identify specific stresses that are harming the forest.

Researchers studied the influence of competition stress on the spectral reflectance of loblolly pine, and found that the degree of competition and the age of the needle strongly influenced the spectral properties. They found strong relationships between several chemical constituents and specific spectral responses for trees grown in the field, but were unable to conclude whether the spectral changes observed were similar to those caused by other stresses, such as air pollutants.

Wood Composite I-Beams Affected by Humidity

As the cost effectiveness of engineered building products improves, wood composite I-beams are becoming more frequently used in medium- and light- frame wood structural systems. For use as a structural member, such products must be strong enough to take service loads and stiff enough to satisfy the serviceability requirements during its lifetime.

A substantial amount of research has been reported concerning the short-term engineering performance of wood composite I-beams under ambient or dry environments. However, for a better understanding of the engineering performances of wood composite beams under service environments and to improve the efficiency of structural design, information with regard to time-dependent flexural behavior as affected by the change of relative humidity/moisture content is needed. To collect this information a multi-phase wood composite beam research program was launched at the Experiment Station.

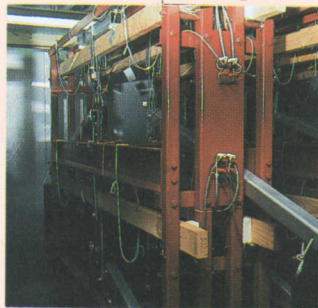
Results indicate that a significant amount

(up to 30 percent) of the total creep deflection was attributable to shear deformation in the webs. RFB I-beams performed the best considering shear, while the change in RH affected OSBI-beam performance the greatest. Slip occurred in the flange web joint over a long period of time and was adversely affected by the increase in RH. However, the magnitude of the slip was quite small and can probably be neglected. The greatest slip occurred in the OSBI-beams, and the least slip was observed in PLY groups. This information will be useful for the improvement of structural design and methods used to manufacture wood composite beams.

Surveys Show Research Valuable to Forest Industry

A recent Experiment Station study demonstrated the importance of forestry research to the competitive economic position of the U.S. industry. The study utilized separate surveys of (1) research institutions (reporting their costs and research success rates), (2) land managers (reporting historical and planned herbicide application rates as well as their stand management strategies for the next 40 years), and (3) herbicide applicators (reporting what they normally charge for herbicide treatments). Data from these surveys were combined with data describing the impact on pine growth, which can be attributed to herbaceous weed control and forecasts of future stumpage values. These were incorporated into a research evaluation model to forecast the future benefits of current and proposed research and the impacts of herbaceous weed control.

Research results indicated that past and future herbaceous weed control research will produce substantial economic benefits. Two different economic models were used to estimate the value of the impacts on pine growth. Both were based on standard forest economics method-



New construction techniques utilizing waste wood will help utilize our total forest resource.

ologies but differed in their assumptions regarding post-treatment management (one assumed stand rotations would be shortened, the other assumed they would remain the same). These methods estimated benefits from research to be between \$111 million and \$143 million, depending upon the discount rate assumed. Internal rates of return also were calculated for the aggregate research program and were estimated at 14.4 percent and 12.3 percent, respectively, for the two evaluation methods.

Lumber Model, SELECT, To Help Furniture Makers

Lumber costs make up about 50 percent of the total cost of producing hardwood furniture, and incorrect lumber allocation is a major reason for the relatively high cost. Forestry researchers at Auburn recently developed SELECT, a computer program that evaluates the efficiency of sorting lumber according to grades and sizes. Widespread use of the program, which can be used on personal computers, could save hardwood furniture manufacturers 25-30 percent in production cost.

Ozone, Acid Rain Effects Begin to Show on Pines

An ongoing concern of the forest industry is a much-disputed reduction in growth rate of pine trees in the Southeast. As part of a region-wide test, Auburn researchers are testing the effect of ozone and acid precipitation—two proposed reasons for reduced growth—on loblolly pines.

One year results (1988) indicate that low levels of neither ozone nor acid rain had a detrimental effect on tree growth. Trees fumigated at the higher concentrations, however, exhibited a significant loss of needles (early senescence) and had visible symptoms of ozone injury. Symptoms varied by family, indicating response was under some genetic control.

Trees exposed to elevated concentrations of ozone in 1988 appear to be more sensitive to winter injury in 1989, than those exposed to am-

bient or filtered air. These findings are under further investigation.

Results from the second growing season (1989) do indicate that trees exposed to the most severe ozone treatment are beginning to exhibit declines in growth, but the analyses are not completed at this time. Trees will be exposed for one more growing season (1990) and then all trees will be harvested.

Weed-Free Plots Produce Fastest Growing Trees

Controlling weeds early may get trees to harvestable size early, according to a recent study. These studies, one of 5 years and one 7 years, demonstrate that herbaceous weed control following planting of pine seedlings enhances tree growth more than any other silvicultural treatment. The growth trends from these studies indicate that the forest stands will be of harvestable size 2-3 years before stands without herbaceous weed control.

At 5 years of age, two herbaceous weed control growth response studies indicate a positive response in tree height, diameter, and basal area per acre in 5 year-old-pines. The Auburn location involved comparisons of band versus spot treatments, and the pine response was proportional to the amount of area treated. Basal area increased over the check by 58 percent and 101 percent for the spot and band treatments, respectively. Complete herbaceous weed control for 2 years in another location increased basal area over the check by 144 percent. Density (trees per acre) was improved by weed control only at the Auburn location. Rust infection was higher for the weed control treatments only at the second location, with most of the

increase due to branch rather than stem infections.

After trees reached 7 years old, results of three herbaceous weed control studies indicate a positive response in pine tree height, diameter, basal area per acre, and volume per acre from weed control. The Chesapeake location compared 2 years of broadcast or banded treatments to an untreated check. Loblolly pine volume per acre at age 7 differed between the two weed control treatments and was 305 cubic feet per acre (87 percent) and 198 cubic feet per acre (56 percent) greater than the check for the broadcast and banded treatments, respectively.

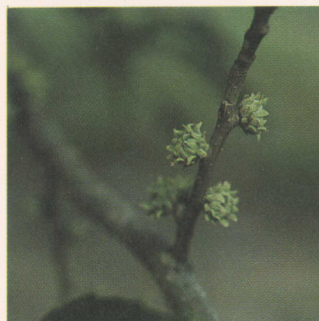
A Packaging Corporation location compared banded and broadcast weed control applied in the first year, and banded and broadcast weed control applied in both the first and second years, to an untreated check in slash pines. Volume per acre did not differ by method (band versus broadcast), but increased with duration (1 year versus 2 years). First-year weed control increased volume per acre at age seven

by 130 cubic feet per acre (38 percent), whereas first-year and second-year weed control increased volume by 208 cubic feet per acre (62 percent). Two years of broadcast vegetation control at the Champion location resulted in a slash pine volume response of 283 cubic feet per acre (127 percent) at age seven.

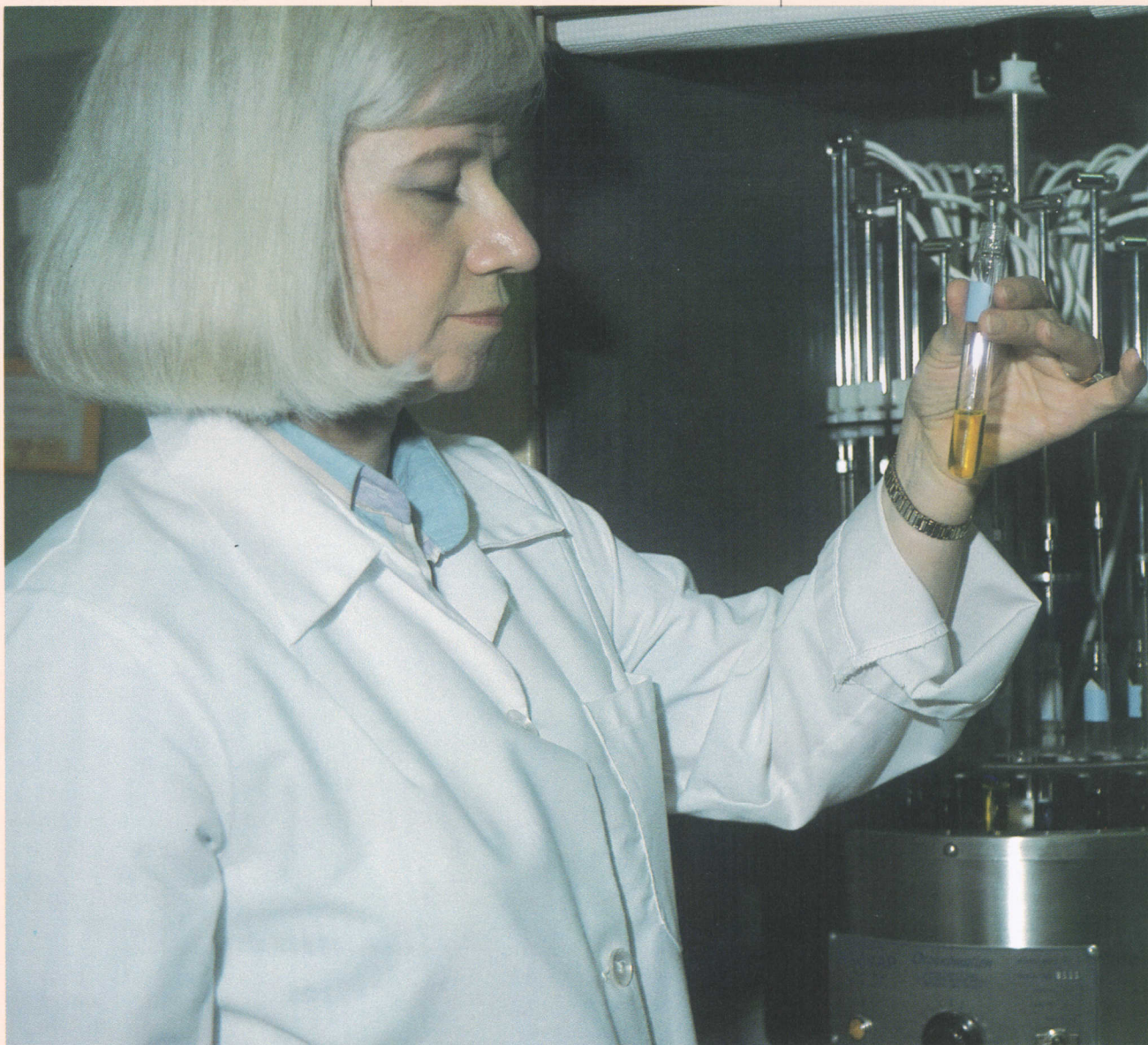
Rust incidence increased with volume response at the Packaging Corporation and Champion sites. Stem rust for loblolly pine ranged from 3 percent for the check to 11 percent for the 2-year weed control treatments. Stem rust for slash pine ranged from 11 percent for the check to 19 percent for the 2-year vegetation control treatment.



Pine seedling remain one of the State's highest value crops, and maintaining a weed free environment is critical.



Atmospheric pollutants that threaten forest growth are being studied by Auburn researchers.



The relationship between the human body and the food we eat has never been so closely scrutinized as today. Not only is the safety of our food and fiber supply being closely watched, but so are the possible negative impacts on nutrition. Though not new to the research program of the Alabama Agricultural Experiment Station, research into the many aspects of this food-body

relationship is certain to reach new heights as we push into the 21st century.

One of the most pressing food-related problems of the current generation has been the so called "microwave diseases" – the most prominent one being salmonella poisoning. The increase in incidence of these diseases, or reporting of these diseases, has created much concern, especially in the poultry

Food safety and human health are being studied by several inter-disciplinary teams.

industry. Experiment Station research is well along in developing a technique, using a naturally occurring, safe compound to combat these disease-causing microbes. Though in initial stages, the research offers high potential for reducing, if not eliminating, surface con-

tamination of poultry products by salmonella.

The Experiment Station has a broad program of research in the area of human health and nutrition. Still, the most visible and certainly most closely scrutinized program is a wide range of projects, each with one common denominator — food.

Fish Oils May Reduce Respiratory Diseases

Fish oils contain omega-3 fatty acids which have been linked to reduced incidence and severity of heart disease. Consumption of this type of fat may be helpful because it results in a decreased production in the body of compounds called eicosanoids. Certain eicosanoids are known to be increased in diseases such as cardiovascular disease, as well as in asthma, allergies, and certain inflammatory responses.

The role of omega-3 fatty acids in respiratory diseases has not been as well-studied as it has in the cardiovascular system. Scientists in the Agricultural Experiment Station are thus investigating the effects of dietary fish oils on the pulmonary system in the hope that omega-3 fatty acids will be beneficial in treating or preventing diseases of the lung in much the same way that this type of fatty acid reduces cardiovascular disease.

Lungs of newborns are particularly vulnerable to disease, thus the researchers used neonatal piglets as a model for the human infant to show that eicosanoids produced by lung tissue are lower in animals fed fish oil than in animals fed either corn oil or coconut oil. Results from these studies have implications for the type that is best for infant formula fed to normal infants as well as those who are undergoing a stress to their lungs. In addition, this research may provide insight into more effective means of treating lung disease, such as asthma, in both children and adults.

Fungi Produce Beneficial Omega 3 Fatty Acids

World-wide interest in health aspects of fat nutrition has been stimulated in part by the apparent

human health benefits of dietary long-chain polyunsaturated fatty acids (PUFA) of the omega-3 type, such as eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids found in the oil of many marine fish species. Research at Auburn has shown that certain primitive fungi produce relatively high amounts of EPA, as well as another PUFA called arachidonic acid (AA), which also has biological activity in mammals. The fungus being used produces about 30 percent fat which contains up to 10 percent AA and 12 percent EPA, which is comparable to production by other fungi being developed for such purposes in Japan. The fungus is amenable to scale up biomass production using fermentation techniques, and therefore represents a potential commercial source of these fatty acids.

Fried Chicken a Good Source of Vitamin B₆

Why eat fast food? One Auburn researcher found at least one good reason. Fast food fried chicken is an excellent source of vitamin B₆ and the vitamin is not destroyed during the cooking process. Vitamin B₆ is one of the B complex vitamins which is stated in many research reports as being low or limited in the diets of certain populations in the United States. The fact is that many of the foods consumed by American consumers have not been evaluated for their content of vitamin B₆. This lack of information has prompted Auburn researchers to evaluate foods for their content of this vitamin. Meats tend to be the best source of vitamin B₆ which is used in many different ways in the body.

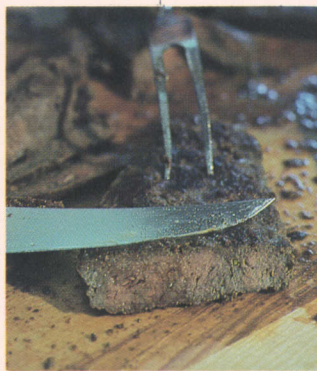
The first step was to determine a method that would have the sensitivity to detect even the smallest levels of the different forms of vitamin B₆. The method developed used high performance li-

quid chromatography (HPLC), which could detect for the six different vitamers of B. This method was used to evaluate chicken samples. Fast food fried chicken samples were first evaluated for their B₆ content, knowing that if a fried sample of food could be analyzed, the problems associated with other less complex foods would follow.

Samples were collected from fast food fried chicken establishments. The chicken pieces were obtained halved, with half remaining raw and the other half prepared according to the individual restaurant standards. The analysis of the matched samples revealed that little of the vitamin was lost during the frying process. This led researchers to conclude that vitamin B₆ is stable at high temperatures for periods up to 20 minutes in a fat media. The breading and batter on the fried chicken may assist in the retention of the vitamin, trapping the juices in the meat and resulting in small losses of the vitamin in processing.

Technology Produces New New Beef Products

A primary goal of the meat industry, as with any industry, is the production of products with maximal returns. This economic concern motivates processors to seek new and innovative technologies for use in the development of new products of higher quality and value, at the lowest cost. Traditionally, beef chucks (27 percent of the beef carcass) have been merchandised as low-priced roasts



New, low fat, lower cholesterol beef products are continuously developed and evaluated by Auburn researchers.

and steaks due to the amount of connective tissue and the widely varying palatability among muscles. Chucks are inexpensive and are attractive as a raw material source for the production of 'value-added' products.

Recently, many technological advances have been used in an attempt to develop restructured products which more closely re-

semble intact cuts of meat. One drawback in manufacturing restructured products with a texture similar to intact muscle is that larger pieces of meat must be used. With the use of larger meat pieces from lower value cuts, there is greater potential for problems with detection of connective tissue.

An Experiment Station study was conducted to determine the effectiveness of the trimming of connective tissue from chuck muscles and the reincorporation of the connective tissue after particle size reduction to restructured roast beef. In this study, the trimming of connective tissue from the chuck muscles resulted in a loss of approximately 20 percent. Results suggest that the particle size of this connective tissue can be reduced and the connective tissue reincorporated into restructured roast beef products without detrimental effects to product sensory quality, thus producing quality products at a reduced cost.

Lean Ground Beef Lowers Fat, Calories

Over 3 billion pounds of ground beef, which is 44 percent of total fresh beef cuts available, is consumed annually in the United States. This ground beef generally contains 20-30 percent fat. A large segment of today's consumer population is health conscious and is concerned about dietary fat. These consumers avoid meat products, such as ground beef, with high fat and caloric content. As today's consumers continue to become more health conscious, their demand for lower fat, ground beef will rapidly expand.

It is important that low-fat, ground beef is developed and tailored to meet the needs of today's diet conscious consumers. Simple reduction of the fat to 5-10 percent would be the most efficient method of developing low-fat ground beef. However, ground beef with a fat content in this range is generally considered less palatable than ground beef with 20-30 percent fat. Therefore, an Experiment Station project was initiated to

develop lean ground beef that will be as acceptable to the consumer as current ground beef.

Through changes in manufacturing processes and addition of food additives, lower fat (10 percent) ground beef products have been developed that possess sensory characteristics that do not differ from the control (20 percent fat). These products contain approximately 40 percent less fat than the control on an "as eaten" basis. Caloric savings obtained from the consumption of these products compared to the control product are between 55 and 60 kcal per 3.5-ounce serving (22-23 percent), with a decrease of 70 calories from fat and an increase of 10 calories from protein.

Use of Plant Fat Lowers Cholesterol in Ground Beef

Popularity of red meat has decreased over the past several years due to negative publicity about the content of dietary cholesterol, calories, and saturated fats in red meat products. Simple reduction of the fat level in ground beef products will not eliminate the problem, since even when the fat level is reduced in ground beef, there is no change in the cholesterol level of the cooked product.

Generally, animal fats have been associated with high amounts of cholesterol and saturated fatty acids, whereas plant fats are associated with unsaturated fatty acids. Plant fats are also a good source of saturated fatty acids, however they do not contain cholesterol. Therefore, a study was initiated to evaluate quality attributes and overall consumer acceptability of ground beef (10 percent) produced with beef fat or various sources of hydrogenated vegetable fat.

Sensory panelists' overall acceptability ratings for ground beef containing hydrogenated corn fat or palm fat did not differ from

ground beef containing beef fat. These results indicate that the replacement of beef fat with hydrogenated plant fat in the manufacture of ground beef is feasible and thus may be an effective method of lowering the cholesterol content of ground beef.

Packaging Problems Remain For Pre-Cooked Roast Beef

Currently, the safety of our food supply is being questioned. As the market for ready-to-eat food items continues to grow, it is essential that the safety of each of these products is evaluated. One such product is pre-cooked roast beef. The process of slicing and packaging pre-cooked roast beef provides an opportunity for contamination of the product with spoilage and pathogenic organisms.

The presence of pathogens in these ready-to-eat items is of great concern. *Staphylococcus aureus* has been identified as one of the primary causative agents in foodborne disease outbreaks. Experiments were designed by food scientists to investigate the antimicrobial effects of potassium sorbate, secondary heat treatment, and reduced pH of vacuum packaged roast beef slices on the persistence of *S. aureus* in products stored under refrigerated conditions.

Results indicate that secondary heat treatment of vacuum packaged, sliced, precooked roast beef lowered *S. aureus* counts in the roast beef. However, this treatment was detrimental to product appearance. The treatment of the

roast beef with potassium sorbate or the lowering of the pH of the roast beef with an acidic solution did not effectively lower *S. aureus* counts. The reduction of *S. aureus* in these products is not sufficient, so other post-processing techniques must be developed to eliminate the pathogen from the product while maintaining product quality.



Development of new products and packaging of these products will provide for more complete use of Alabama-raised beef.



Wise use of our natural resources is an ongoing research emphasis in the Experiment Station. Depletion of these resources or depredation from soil, air, or water pollution is a threat to both agricultural and nonagricultural areas of the State.

Alabama, for example, ranks second nationally in broiler chicken production, but this production

Experiment Station researchers must also be environmentalists, thus the impact of production practices on our water, soil, and air are constantly monitored.

level also produces about 2 million tons of chicken litter annually. The poultry industry has played a leadership role in developing alternative uses of this waste byproduct.

Experiment Station research has explored uses of litter ranging from fertilizer for vegetable crops, to potting soil for ornamentals, to feed for

livestock. A recent Experiment Station survey indicated that litter of average composition has a value of \$29 per ton based on its use as a fertilizer and \$105 per ton if the crude protein, fiber, and mineral content is considered for use as a feed ingredient for ruminant animals. Similar studies demonstrated that 35 to 40 percent of the carbohydrates in certain crop residues can be converted to ethanol, lactic acid, and citric acid. Remaining residues are protein enriched by the spent fermentation microorganisms, and these residues have economic value as a source of high quality protein animal feed.

Wastewater generated by agribusiness is a potential source of environmental pollutant that requires treatment prior to disposal. Auburn researchers are exploring the use of microorganisms to treat wastewater and to convert the nutrients in wastewater to microbial protein which can be recovered and used as feed for animals. Equally innovative work is being done involving soil, water, and air factors effecting plant production, plus the effects of the environment on man.

Hydrilla Control Possible with Sterile Grass Carp

A new exotic plant, called hydrilla, has become a threat to fishing and recreation on Lake Guntersville—Alabama's largest lake. Experiment Station researchers recently found that sterile grass carp can help reduce hydrilla, but precautions must be taken.

The method of producing sterile grass carp, or white amur, was developed in 1983, making it possible to test these voracious feeders in open water without fear of ongoing environmental damage. As a result, Auburn researchers, working in cooperation with the Tennessee Valley Authority, released 25 juvenile and 10 adult grass carp into Guntersville Reservoir.

The juvenile grass carp moved an average of 1.4 miles during summer and reduced movement when water temperatures declined in the fall. These fish tended to move upstream and typically remained in hydrilla-dominated areas. Surprisingly, the adult grass carp moved an average of 20 miles soon after stocking and did not reduce movement when water temperatures began to cool.

There is clear evidence that grass carp can adversely affect waterfowl populations by destroying the hydrilla that is preferred nesting and feeding habitat for ducks. By using high stocking rates of juveniles, researchers expect to control the expansion of hydrilla, without significantly destroying areas of the grass used by waterfowl.

Cattle Egrets Provide Environmental Insights

Cattle egrets provide more than a scenic touch to the pastures they visit. Experiment Station research has shown that they can help control insect populations and also are valuable indicators of environmental pressures.

Egrets are colonial waterbirds, birds which nest in or near water in large colonies. By studying egrets and their kin (herons, ibises, gulls, and other birds), scientists have learned more about their lifecycles and have gained insight into the delicate ecosystems of the wetland and shore areas they inhabit.

Recent studies of egrets during drought years have shown that the birds are more likely to endure dry weather if abundant pastures are available for feeding. Human harassment of egrets severely impacted nesting habits and eventually dispersed colonies.

These data indicate that egrets are highly susceptible to environmental pressures and suggest that Alabama can keep an attractive, helpful member of its wildlife community by protecting their environment and their privacy.

Alabamians Aware of Dangers of Hazardous Materials
An Experiment Station study, based on results from three separate

mail surveys conducted during the summer and fall of 1988, clearly shows that Alabamians see hazardous waste management as a major national problem which presents serious threats to their own communities.

A total of 1,200 questionnaires were sent to a random sample of Alabama residents, of which 399 were returned. A further 200 were sent (and 69 returned) to residents of Sumter County, location of the nation's largest hazardous waste landfill. The third group surveyed (200 questionnaires, 127 returned) was the membership of the Alabama chapter of the Sierra Club.

The surveys show that Alabamians are unwilling to trade environmental quality for economic development. All three groups surveyed expressed a strong desire to create more jobs. Most Alabamians said they were willing to pay more for products if this was necessary to promote recycling and waste reduction processes.

The surveys also show that Alabamians have considerable faith and confidence in the Environmental Protection Agency and the Alabama Department of Environmental Management as key agencies in managing hazardous wastes. Alabamians do not believe the private sector should be involved in making decisions on where to locate hazardous waste management facilities, although under the present regulatory structure the initiative in siting new facilities generally is with private firms. Alabamians strongly feel that only scientific experts in the field should make decisions regarding hazardous waste management.

New Termite a Threat in Parts of Alabama

The Formosan subterranean termite is one of the most destructive termite species worldwide. This termite is an important pest in trop-

ical and subtropical areas such as Guam, Taiwan, the Philippines, and Hawaii. In Hawaii, it is estimated that over \$60 million is spent annually to control this termite. In the continental United States, the Formosan subterranean termite has been reported primarily in coastal cities from Houston to central Florida, which have ports that service shipping from the Far East and Hawaii. There are no estimates of Formosan termite damage in Alabama, although the termite has been reported in Mobile and Baldwin counties and as far inland as Auburn.

All reports of Formosan subterranean termite infestations in the United States, except the one in Auburn, have been near ports or inland waterways. This termite was probably introduced into the Southeast with infested marine cargo in ships returning from the Pacific theater at the end of World War II and the Korean conflict.

Subsequent infestations have been caused by transportation of infested wood.

Because of the economic importance of the Formosan subterranean termite, research was undertaken by the Experiment Station to determine the distribution of this pest in Alabama. In addition, physiological factors that may reflect the behavior and distribution of this pest were contrasted with those of native eastern subterranean termites.

Because the Formosan subterranean termite is distributed in warm, usually humid regions and frequently near water, aspects of their temperature relations were investigated and compared to the native eastern subterranean termite. Termites were heated or cooled at a constant rate (3.4°F per minute) to determine the temperatures at which they lost the ability to move (knockdown). Formosan subterra-



Formosan termites, previously found only near Alabama's port city of Mobile, have been found by Auburn researchers in Lee County and could pose a threat to homeowners.

mean termites were knocked down at about 3.4° hotter than native eastern subterranean termites. This result indicates that Formosan termites can withstand higher temperatures than native termites. Eastern subterranean termites tolerated slightly lower temperatures than Formosan termites.

Millet Removes Excess N From Poultry Litter Fertilizer

One of the biggest problems with using poultry litter as a N source is applying a sufficient quantity of litter to supply the recommended adequate amount of N without applying excessive N that can end up as an environmental pollutant. It is easy to determine the total amount of N in litter, but it is extremely difficult to determine how much of the N will release during the growing season, and how much will be released to the environment.

Tests were conducted in the spring of 1989 to determine the amount of N used by millet and wheat. As a result of wet conditions, the wheat was harvested later than normal and the following millet crop was planted approximately 3 weeks later than normal. Despite the late planting date, millet growth was excellent. Millet dry weights on the first cutting (August 30) averaged 2,600, 6,000, and 7,600 pounds per acre when inorganic N fertilizer, 4 tons per acre litter, and 8 tons per acre litter, respectively, were applied to the previous wheat crop (the millet was not fertilized). The amount of N removed in the wheat

grain plus millet tissue averaged 44 and 38 percent of the N applied in the 4- and 8-ton per acre litter treatments, respectively. The 44 percent N recovery from the low rate of litter is as good as can be expected from inorganic N fertilizer.

The results of the first year of this test strongly indicate that when poultry litter is the sole N source for wheat, total N in the wheat will have to exceed three times the N fertilizer requirements for wheat, and that 80 percent of this N will be left in the environmental system after wheat grain harvest. However, if a crop such as millet, that uses large amounts of N, follows the wheat, a reasonable percentage of the excess N can be removed from the environmental system.

Environmentally Safe Sprays Effective for Stinging Insects

Wasps, hornets, and other stinging insects are a constant pest and potential health hazard to highly allergic individuals. Though most sprays are used by homeowners, many service industries, especially utilities, also must use sprays to protect their workers. Finding sprays that are effective, but not damaging to materials in the environment was the focus of a recent Experiment Station study.

Electronic and telecommunications industries must use wasp spray formulations that do not damage plastic, which is used to form telephones, splice cases, and most importantly insulate wires. High di-

electric constant, nonflammability, and low corrosiveness are also important characteristics for wasp sprays used in and around electrical equipment.

In the Auburn test, 1-minute knockdown ranged from 27 to 100 percent and could be categorized into three groups: more than 98 percent, 89 to 98 percent, and less than 89 percent. Except for Wasp Killer II, all formulations that had 100 percent knockdown also damaged some type of plastic. All formulations having one minute knockdown between 98 and 81 percent also damaged at least one type of plastic. The two formulations with the lowest knockdown (Black-flag and SCS) did not damage plastics. All formulations gave 100 percent kill 5 minutes after spraying.

In further studies, there was no correlation between 1-minute knockdown and any of the active ingredients in the wasp and hornet sprays. There was, however, a significant correlation between knockdown and the chilling effects of the sprays. The body temperature of honey bees used in the test was continuously recorded and sprays applied. Formulations giving the best knockdown lowered body temperature the most. These formulations contained Freons, methelene chloride, and other volatile solvents.

Rapid knockdown of stinging insects is the most important characteristic of wasp and hornet sprays used in electrical and telecommunication industries. Technicians are often faced with wasps infesting suspended aerial equipment. Control also must be immediate since wasp stings might severely affect worker safety, especially when workers are 20-30 feet above the ground. Wasp sprays also must not damage equipment. These studies indicate that rapid knockdown is due to body temperature depression rather than the active ingredients per se and can be accomplished without damaging plastics.

Auburn researchers monitor land, soil, and air for pollution from a variety of sources.





Though Alabama's metropolitan areas are increasing in population, a large segment of the State's people still live in rural areas. Typical of rural families are husbands and wives with both on and off-farm jobs. Many opportunities exist for rural residents.

A recent survey, for example, indicated that greater flexibility in work schedules among family members is essential for most rural families with both on-farm and off-farm employment. Education was also listed as essential in both obtaining and enjoying off-farm

employment by rural residents.

Surveys of farm families indicate that farm crime and financial recovery remain problems for Alabama's farmers. For those seeking to develop rural industries, one study indicates that finding a suitable labor force is a problem.

Recreation Use Model Developed for State Forests

A model of the recreational use of Bankhead National Forest in Alabama was completed. It accurately estimates the number of visitors to the forest in a given year. The model also estimates the alloca-

Improving rural life by understanding the needs of those living outside metropolitan areas is being studied by Auburn researchers.

tion of visitors among various areas of the forest based on the Recreation Opportunity Spectrum (ROS). In addition, ROS classes of the forest were modified following a newly developed classification system which shows promise for all Eastern national forests.

Implications of adoption of the new system and the estimation model are significant. First, the new ROS system will mean more diversity of forest use in the East in accordance with the multiple use

directives of the federal government. Second, the ability to accurately estimate visitor numbers and their choice of recreational activities will mean better management of forest resources for timber production as well as recreational use.

Money is Main Source of Farm Family Stress

The severe financial crisis facing many rural farm families in Alabama has served to focus attention on how families successfully adjust to both expected and unexpected changes in their lives. Researchers at Auburn have begun to identify sources of stress and types of coping strategies common to these families by conducting research with couples who live on a farm or in a rural area.

The life stressors most frequently reported by these couples were those associated with increased strain on the family's money supply and strains arising from a family-owned business or investment. These changes were followed in frequency by strains within the family, including reports of increased tension and conflict between family members and increased difficulties associated with being a parent. The third most likely type of stressor experienced by these couples was change associated with work, including changing jobs, being fired, retirement, and job promotions. Couples were least likely to report stressors due to changes in the marriage, death of a family member or friend, family members moving in or out of the home, illness, or legal problems.

With regard to coping strategies, the descriptive data revealed that couples used a variety of coping strategies to deal with difficulties in their lives. Both husbands and wives reported that they typically coped with change by seeking spiritual support and by facing problems head-on with confidence in their ability to handle problems. They reported somewhat less frequently that they relied on relatives, friends, neighbors,

and extended family in times of need. They were least likely to seek professional counseling, assistance from community agencies, and information and advice from the family doctor when faced with problems.

Alabama Farmers Concerned Over Rural Crime Increase

A statewide survey of Alabama farm operators sought to determine opinions about and experiences with crime and vandalism to farms. Questionnaires were completed by 428 farmers who provided information never before obtained about the extent and impact of farm crime in the agricultural sector. For the first time, data are available on a wide variety of crimes against farm property, including crimes both reported and unreported to law enforcement authorities. Also, unique information now exists about perceptions of changes in the number of farm crimes and the seriousness of various types of farm crime in local rural communities.

A key finding is the extent to which Alabama farm operators view current trends in farm crime as increasing. Two separate questions asked independently provided highly similar results. About 35 percent believed farm crime had increased in their local community within the past 2 years. Similarly, 40 percent believed that the theft of farm property in their local community had increased in this same time period. The consistency of these two responses indicates that crimes committed against farm property is a growing concern to Alabama farmers.

Additional questions focused on specific aspects of farm crime. About 65 percent were worried about the safety of farm property such as machinery, livestock, crops, and supplies.

Also, 27 percent reported being fearful about going to certain areas of their farm after dark.

The offenses most frequently considered serious problems were: (1) poaching of fish and wildlife—42 percent; (2) trespassing on farmland—40 percent; (3) vandalism by dumping trash on farmland—36 percent; (4) outsiders planting marijuana on farmland—30 percent; (5) arson of woods, fields or buildings—29 percent; and (6) burglary of farm buildings—28 percent. Five other types of crime or vandalism offenses were noted as serious by 17 percent or more of these farmers.

Lake Weiss a Big Part of County Economy

Lake Weiss is known to fishermen throughout the Southeast as "The Crappie Capital of the World." A recent Experiment Station survey indicates the lake in northeast Alabama plays a key role in the economy of Cherokee County.

A survey was conducted in Cherokee County, Alabama, of the Lake Weiss business community. From a total of nearly 500 businesses, a subsample of 150 businesses was randomly chosen which represented six strata

of fishery-related businesses. Of these businesses, a 50 percent sample of business owners was interviewed.

The mean percentage of gross business income contributed by fishery activities for the entire community was 21 percent, or 11.3 million dollars. Businesses that earned at least 15 percent of their income from fishery-related activity considered that portion of income to be vital to their success. Ninety percent of business owners felt that the fishery would expand in the future.



Studies indicate that fisheries-related businesses on Lake Weiss have a major impact on the economies of the county and area.



Cotton, peanuts, poultry, cattle, and timber remain traditional crops for Alabama producers. However, many new crops have been worked into traditional agriculture in recent years and many others are being tested by Experiment Station researchers for future use.

Farm-raised catfish is the most obvious new crop success story, having started as an industry in west Alabama in the mid-1960's. In more recent years blueberries have become significant income producers in Clay and Escambia counties and production is widespread throughout the State. Experiment Station researchers are constantly evaluating crops and

services to find the next one to impact on the State's economy.

Lack of Quality Labor Restricts Apparel Industry

Apparel manufacturing is an important component of the rural revitalization potential of Alabama. Alabama's apparel industry with 56,000 workers accounts for approximately 15 percent of the manufacturing employment in the State. The industry's 1988 payroll was over \$500 million. Alabama and California are the only states in the United States to show an increase in apparel industry employment between 1978 and 1988. In fact, Alabama had a 24 percent increase in the number of textile and apparel plants,

Strawberries, blueberries, and kiwi are among several alternative crops being tested for possible commercial production in Alabama.

Experiment Station research efforts have concentrated on identifying the factors that can make companies more competitive and obstacles that reduce their competitiveness. The increased emphasis on quick response as a means to meet consumer demands is the primary competitive edge available to American manufacturers as they strive to compete with imports from low wage level countries. However, quick response requires a flexible work environment in terms of workers, equipment, and manufacturing approaches.

The primary concern identified in interviews with industry personnel around the State was the unavailability of qualified labor. The need exists for people with apparel-related college degrees to move into mid-level management positions. They are needed to help meet the challenges of change in technology, distribution channels, sources of raw materials, and consumer demand. In addition, entry-level operators are needed who have a good work ethic and a willingness to learn and adapt.

A number of plant managers indicated that they had enough potential orders to expand production by as much as 100 percent, but they could not get the workers. Such expansions would not only create jobs for Alabamians, but the wages earned and the products made would generate tax revenues which would benefit all of Alabama's citizens.

Tourism Potential Explored in North Alabama Counties

A recent Experiment Station study has determined that there are reasonable gains to be made by the residents of both Lawrence and Winston counties in Alabama through the development of a tourism industry. Abundant natural resources in both counties provide a significant base upon which to begin building a tourism program. However, several infrastructural problems in both public and private sectors of each county, as well as a general lack of tourism support facilities, create barriers which must be addressed if any tourism program is to attain its full economic potential.

Estimates of tourist-related spending in Lawrence County currently approach approximately \$288,500 annually. However, this figure could likely be increased one and a half to two times with the proper development and adequate food and lodging facilities. Likewise, Winston County could realise up to \$1,000,000 annually in tourist-related spending when a full-tourism industry with support facilities is in place.

Potential economic gains from the development of a coordinated county-wide tourism industry exist in both Lawrence and Winston counties. Whether these gains warrant the use of implementation and development will depend heavily on the support of the entire county populace, as well as the strength and commitment of the local government.

New Plant to Boost Interior Foliage Business

Nurserymen, tissue culture labs, and retailers will benefit from increased production of Harbour Dwarf nandina, an easy to grow and maintain foliage plant. Auburn research indicates Harbour Dwarf may lead the way in revitalizing Alabama's interior foliage plant industry.

The market for interior foliage plants has declined in terms of the number of producers, production area, and wholesale value since the foliage plant boom of the 1970's. When market demand levels, profits decline dramatically and the market is considered to be mature. In order to rejuvenate this market, new crops must be introduced to stimulate demand. Harbour Dwarf is traditionally used as an exterior landscape plant, however, its delicate looking foliage spreads in a unique horizontal manner, and the plant is quite attractive when grown in a 5-inch pot.

Preliminary research indicates that the leaves remain intact and retain their rich green color even after plants have been in a low light interior environment for several weeks. The attractiveness of Harbour Dwarf nandinas, their economical production costs, and their good postproduction life indicate excellent potential as an interior potted plant.

The market potential of Harbour Dwarf nandinas was evaluated in four Birmingham

supermarkets. Consumers purchased the plants at a price and a rate similar to foliage plants of the same size, indicating that Harbour Dwarf nandinas are as acceptable as many other traditional foliage plants for use in interior environments.

State's First Kiwi Harvest Offers a Few Surprises

The first kiwi research work conducted in Alabama was begun in 1986. The research was initiated after considerable interest in kiwi production by Alabama growers was evident and many commercial plantings had been or were being established. The kiwi (*Actinidia chinenses* Planch) has the potential of a high value crop for Alabama and other Southeastern states. The weather and other environmental consideration in the Southeast are favorable for kiwi production, however, certain cultural and production practices that are currently utilized must be modified for optimum plant performance.

Current data collected indicate Hayward female variety (the leading female variety in world fruit production) has problems with bud break and initiation and development of female flowers under the environmental conditions of the Southeast. It has not produced the plant vigor, shoot growth, or fruit yield of Fitzgerald or another seedling under evaluation.

The male variety Matura bloom period adequately overlapped the first half of the female bloom period as desired. However, the Tomuri male variety bloomed after the female varieties and did not overlap at the last half of the female bloom period as desired and reported in the literature.

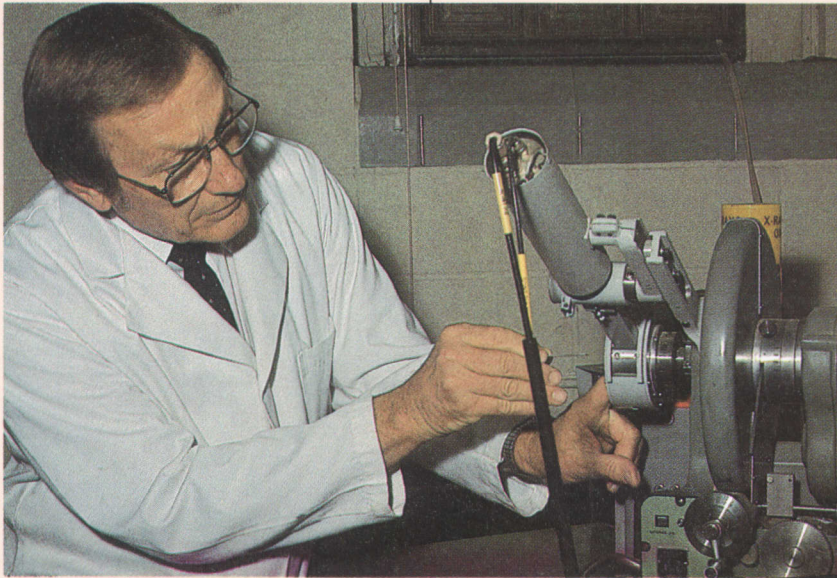
Fruit of the Fitzgerald has the same quality, but is not as large as the Hayward. However, it should be of acceptable commercial size.



Experiment Station researchers are constantly seeking to develop new crop products, such as the kiwi fruit shown here, to add flexibility and profit to Alabama farm operations.

D

IRECTOR'S RESEARCH AWARDS



Ben Hajek (top), professor of agronomy and soils, was recently presented the annual Director's Senior Research Award. The \$10,000 award is sponsored by the Experiment Station and can be used by the researcher to enhance his/her research efforts.

Ray Henry (above), associate professor of zoology and wildlife sciences, was presented the Direc-

tor's Research Award for Associate and Assistant Professor rank. it is also a \$10,000 award.

The Director's Research Award has become one of the most coveted and competitive awards for Experiment Station scientists. Initiated in 1981 to recognize special lifetime achievements, researchers are nominated for the award by their peers and winners are selected by a committee of their peers.

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INANCIAL REPORT

Alabama
Agricultural
Experiment Station
Report of Revenue
For The
Fiscal Year Ending
September 30, 1989

APPROPRIATED FUNDS

State	\$15,694,805	51.0%
State Paid Employee Benefits	\$ 1,691,151	5.5%
Federal	\$ 3,993,691	13.0%

CONTRACTS AND GRANTS

Federal	\$ 1,856,035
State	645,781
Private	2,409,561
	\$ 4,911,377 16.0%

AUXILIARY REVENUES

Sale of Research Products	\$ 3,471,971
Diagnostic Services & Fees	251,583
Interest and Royalties	288,837
Indirect and Other Cost Recovery	465,861
	\$ 4,478,252 14.6%

TOTAL REVENUES \$30,769,276 100.0%



**The
Alabama
Agricultural
Experiment
Station**