Mississippi State University **Office of Agricultural Communications**

# MAFES Research Highlights

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## Fall 1997 60:04

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### From the Director:

There was a time, not too many years ago, when changes in agriculture took years to implement. The shift from animal-powered farm equipment that began in the latter part of the last century was not completed until past the halfway point of this century. The widespread use of chemicals for control of insects, weeds, and plant diseases was perfected and phased in over three decades.

Today, the men and women who produce our food and fiber don't have three decades or even 3 years in some cases, to adapt new technology to their farming operations. Every aspect of agriculture today is accelerated, just like other industries that depend on new technology. Computerized management systems, genetically engineered plants, precision farming with remote sensing equipment, and other high-tech innovations are rapidly becoming necessary parts of farmers' everyday lives.

MAFES scientists help make the adoption of new technology easier for farmers by testing and evaluating new products and management systems. They also work to develop products and management techniques that fit the specific needs of Mississippi agriculture.

The work of MAFES researchers is not, however, limited to just projects that impact production agriculture. All Mississippians benefit from research in the areas of consumer product development and evaluation. Some of the research in those areas is featured in this issue of Highlights.

One article focuses on research with low-fat cheeses. These cheeses promise to provide benefits both for consumers looking for low-fat alternatives to their favorite cheeses and for soybean producers. Another feature spotlights the ornamental horticulture research at the South Mississippi Branch and the support it provides for the State's commercial nurseries and for consumers of the products and services provided by the ornamental horticulture industry.

As 1997 draws to a close, MAFES researchers throughout the State are studying the results of their work during the year and are using what they've learned to plan projects for 1998 that will continue to produce benefits for all Mississippians.

## Research seeks modern version of an ancient food

The details of the discovery of cheese are lost in antiquity, but according to legend, an unknown Arab nomad filled a saddlebag with milk to sustain him on a journey across the desert by horse. After several hours of riding, he stopped to quench his thirst, only to find that the milk had separated into a pale watery liquid and solid white lumps.

The saddlebag, which was made from the stomach of a young animal, contained a coagulating enzyme known as rennin. The combination of the rennin, the hot sun, and the galloping motions of the horse caused the milk to separate into curds and whey. The nomad, unconcerned with the technical details, found the whey drinkable and the curds edible.

The cheese-making process was greatly refined by the Romans, and during the Middle Ages, monks developed many of the classic varieties of cheese available today.

Cheese is one of the most nutritious foods, with many varieties containing a protein value equal to that of red meat. In today's health-conscious world, however, many people shy away from cheese because of its fat content. Cheeses at the top end of the fat scale can have a fat content up to 75 percent, although most are about 40- to 50-percent fat.

Low-fat cheeses have been developed in recent years, but problems with taste and texture have limited their acceptance by consumers. Research by Dairy Plant Superintendent Noel Hall has yielded a low-fat Edam cheese that has overcome the traditional problems by extending the ripening process.

Additional MAFES research is aimed at improving the taste and texture of low-fat versions of other popular types of cheese. One of the projects is being conducted by Food Scientist MaryAnne Drake. She is working to develop a low-fat cheddar cheese similar in taste and texture to the full-fat cheddars that are among the most popular with consumers. An additional goal of her research is to improve the yield of low-fat cheese. Low yields from the manufacturing process are a problem for producers and ultimately lead to higher prices for low-fat cheeses.

The key to solving the problems with low-fat cheddar, she believes, could be the addition of soy lecithin.

"Soybeans are the number-one oilseed in the world, and lecithin is produced as a by-product during the processing of soybean oil," Drake says. "Soy lecithin is currently used in many applications, including as an emulsifier in cakes, margarines, chocolates,

and other foods. It has not, however, been used commercially in natural or processed cheese."

Drake came to Mississippi State in 1996 from Washington State University, where she began her research with soy lecithin in low-fat cheeses. The Washington State research demonstrated that granulated soy lecithin improved the yield and texture of 33-percent-reduced-fat cheddar cheese. Flavor, however, was not as good as with full-fat cheese.

Improved flavor and production of cheddar cheese with 75-percent-reduced fat are the goals of Drake's research at Mississippi State.

"Fat is important in the flavor and texture of cheese," she explains. "The reasons for the importance of fat may be seen by looking at the microstructure of full-fat and low-fat cheeses. Full-fat cheese has a protein matrix interspersed liberally with fat globules, whereas reduced- and low-fat cheeses have large stretches of uninterrupted protein with just a few fat globules scattered between."

The MAFES food scientist adds that lecithin may aid in fat dispersion and incorporation of water in reduced-fat cheeses.

The study with the use of soy lecithin in low-fat natural cheddar cheese at Mississippi State began in 1996 with three types of soy lecithin - granular water dispersible, hydrogenated, and liquid oil soluble. The lecithin has been donated to the University by Central Soya Co., of Fort Wayne, IN; Lucas Meyer Inc., of Decatur, IL; Archer Daniels Midland Co., of Decatur, IL; and Riceland Foods, of Little Rock, AR. "We are looking at soy lecithins from different companies because different brands of lecithin have varying degrees of flavor," Drake explains.

A flavor and texture evaluation by an expert sensory panel was conducted after the cheeses made from the various brands of lecithins had aged 1 week. A second evaluation was made after 1 month of aging.

"The texture and the body of the reduced-fat cheddar produced with soy lecithin compares well with full-fat cheddar," explains sensory panel member Kyle Jensen. "Additional research is needed to perfect the flavor, but the outlook is promising for a product that will have good consumer acceptance."

The treatments that received the highest marks from the sensory panel have been incorporated into a large-scale study. Batches of the cheeses have been made and are being aged for 3 months. After aging, they will undergo instrumental and sensory evaluation.

## Edam cheese: A Mississippi State tradition

The resolute bulldog and cowbell are the most widely recognized symbols of Mississippi State University, but the distinctive 3-pound "cannon ball" of Edam cheese produced at the University is not far behind.

The idea to manufacture a cheese to represent Mississippi State originated with Dairy Scientist F.H. Herzer in 1938. At that time, the area surrounding what was then Mississippi State College was one of the South's leading dairy centers, and Herzer

wanted a product that would symbol ize the College's work in support of the dairy industry. The decision was made to manufacture Edam because of its distinctive shape, traditional quality, and the fact that Mississippi State would be the first to produce Edam in the South.

Edam originated in Holland, and Herzer placed a rush order with Dutch manufacturers for 10 teakwood hoops, or molds, in 1938. The order was shipped just before Dutch ports were closed by the outbreak of World War II.

The small number of hoops available for Edam production limited output to just a few hundred balls per year during and following the war years, but demand increased, and production was expanded in 1957 with the purchase of 50 new hoops.

By 1963, production was up to 2,400 Edams a year and research had improved methods of aging, pressing, and salting the cheese. The technique of dipping the Edams in bright red wax, which minimized surface mold growth and made the cheese more attractive, also had been perfected. The addition of an airtight Cry-O-Vacr plastic bag provided additional assurance of quality and permitted the Mississippi State seal to be placed on the product.

In 1970, the cheese-making operation moved into the new Herzer Dairy Science Building and production capacity increased to 165 Edam balls per day.

Production capabilities have continued to increase and improve. Today, a team of full-time employees, food-science students, and researchers produce about 50,000 Mississippi State Edam cheese balls each year.

## Cotton research heats up at Mississippi State

Is the earth getting hotter? Scientists around the world are studying weather patterns and other data to determine if the phenomenon known as "global warming" is actually occurring. Although the global- warming debate will likely continue for some time, there are documented changes in the chemistry of Earth's atmosphere.

"Data collected since 1958 show concentrations of carbon dioxide ($CO_2$) in the atmosphere have increased at the rate of about 1.8 parts per million (ppm) per year," explains MAFES Agronomist Harry Hodges. "The $CO_2$ concentration in the atmosphere was about 315 ppm in 1958. Today it is about 360 and is predicted to reach 700 by the year 2070."

The use of fossil fuels is thought to be a primary reason $CO_2$ levels are on the increase. As $CO_2$ and other gases in the atmosphere increase, they act as a blanket, holding more heat from the sun in Earth's atmosphere rather than letting it escape as heat and long-wave radiation. The result is often referred to as the "greenhouse effect."

The rising $CO_2$ levels will not directly affect humans. The air we breathe is 78 percent nitrogen and 21 percent oxygen. The remaining 1 percent is a combination of $CO_2$, argon, neon, and helium. Growth patterns of plants, however, can be changed by increased amounts of $CO_2$.

Hodges and MAFES Plant Physiologist Raja Reddy are studying the effects of rising $CO_2$

levels and the resulting higher temperatures on cotton. Their study began 8 years ago and continues the work started more than 20 years ago at Mississippi State to provide information needed for the GOSSYM- COMAX cotton crop computer simulation model.

"Temperature is critical for the cotton plant," Reddy explains. "If average daily temperatures are too high for a sustained period of time, young cotton bolls will drop off within 3 or 4 days after they are set."

The MAFES scientists are conducting their study in a group of chambers known as Soil Plant Atmosphere Research (SPAR) units at the USDA/ARS Plant Science Farm on the Missi ssippi State campus. They are assisted in their work by USDA/ARS Research Leader James McKinion and other USDA personnel.

The SPAR units are located outdoors and can accurately control temperature and CO2 for plant- growth studies in an almost natural solar-radiation environment. Only two other facilities in the Nation have similar capabilities to study plants under natural light and with controlled temperatures and CO2 levels.

Using the SPAR units, Hodges and Reddy are studying the responses of cotton plants to various temperatures and to CO2 levels from 350 ppm to 700 ppm and a range of water and nutrient conditions. In 1995, the researchers conducted an experiment in which the controlled temperatures in the units were based on outdoor temperatures. Some chambers were kept at the outside temperature, whereas others were kept 5, 9, or 14 degrees warmer than the temperature outside.

"If the average daily temperature in the chambers was over 84 F, few bolls were retained on the plants," Hodges explains. "At very high temperatures, none reached maturity." In a different study, temperatures were controlled from the beginning of flowering to duplicate the long-term average daily temperatures at Stoneville. The results were similar, with fruit loss at an average daily temperature above 81 F.

The other major focus of the research by the MAFES scientists is the response of cotton plants to changes in CO2 levels.

Plants like CO2 because it stimulates increased photosynthesis, growth, and yields. The problem for cotton and other heat-sensitive plants is that the greenhouse effect resulting from increased CO2 levels causes temperatures to rise.

Although there is considerable debate whether the increasing atmospheric CO2 will cause average global temperatures to increase, several studies have concluded average temperatures could be about 3 to 10 F higher than at the present sometime during the latter part of the next century. This effect is predicted to vary over the earth's surface, with an increase expected in Mississippi of about 8 to 10 F. The study shows that the rate of forming the first square, flower, or open boll is not enhanced by increased CO2. It does show, however, that early-season growth of cotton increases significantly under higher temperatures.

"In our studies, leaf area, plant heights, and dry weight of plants grown 20 days at average daily temperatures of 82 F were six to eight times more than for plants grown at 70 F," says Reddy. "Fruiting sites also increase at higher temperatures. We found that a 3 to 5 F increase in average temperature caused more rapid addition of fruiting sites and

that plants followed through and produced squares and flowers at those sites."

The researchers explain that understanding how cotton plants respond to temperature and other atmospheric changes will help plant breeders develop varieties that are well adapted to the climate where they will be grown.

"Using short-season varieties and altering planting dates could help cotton producers of the future avoid problems with hotter summers by starting the crop earlier in the spring and completing the growing season earlier," Hodges says.

The researchers also have found that growing cotton under high levels of CO2 uses water more efficiently. Ground-water loss, however, is almost the same as at current CO2 levels. This finding suggests that irrigation of crops will continue to be an important part of agricultural production in the future.

"In a high CO2 environment, a cotton plant is slightly more efficient in mild water-stress conditions because the tiny, mouth-like openings called stomates on the leaves don't have to fully open to take in sufficient CO2. The result is less water loss," Reddy says. "Overall water needs, however, remain about the same because of the increased vegetative growth triggered by the elevated CO2." In addition to pointing out the need to change management strategies for cotton, the Mississippi State study and similar research with other crops at other locations indicate the world's food supply also may be altered by rising temperatures.

"It appears likely that most grain and fruit-bearing crops, which provide most of the world's food and fiber supply, are sensitive to high temperatures, and their production will be limited by increases in global temperature," Hodges explains. "On the other hand, the vegetative structures of plants are less sensitive to high temperatures, and if global warming does occur, mankind's diet may shift so more nutrition will be derived directly from leaves, stems, and roots and from animals that consume these structures."

Hodges and Reddy, along with USDA/ARS scientists at Mississippi State, are continuing their efforts to unravel the mysteries surrounding plants' responses to possible future weather changes.

They hope to develop plants that can better withstand short periods of extreme weather events, such as high temperatures during fruiting. They also emphasize that their research can help cotton producers with water management under current conditions, as well as in a possibly warmer future.

## Quality product brings sweet success to Mississippi producers

These are exciting times for Mississippi's sweetpotato producers. Consumers have rediscovered the sweetpotato as a tasty source of fiber and important vitamins. The resulting increased demand has helped almost double sweetpotato production in the State.

"There are about 8,600 acres of sweetpotatoes in the State this year," says Benny Graves, a plant pathologist with the Mississippi Department of Agriculture and Commerce's Bureau of Plant Industry. "The 1997 acreage is a 40-percent increase over just 2 years ago."

The sweetpotato has always been a popular food in the South, but demand declined following World War II as foods with less preparation time gained popularity. Today, new cooking methods, new sweetpotato products, and consumer demand for healthy foods have shoppers taking home more of the orange roots from grocery stores.

"The sweetpotato is high in fiber, contains no cholesterol, and is low in sodium," Graves explains. "One serving supplies all the daily requirements for vitamin A and one-third of daily vitamin C requirements."

Most of Mississippi's sweetpotatoes are grown in Chickasaw, Calhoun, and Pontotoc Counties. In fact, the town of Vardaman in Calhoun County is the self-proclaimed "Sweetpotato Capital of the World."

The Pontotoc Branch Experiment Station is located in the middle of the State's sweetpotato area, and there is a strong commitment to sweetpotato research at the Station. The largest single program at Pontotoc is the production of foundation sweetpotato seed. The Station operates one of only three foundation sweetpotato programs in the South.

The sweetpotato is a cousin of the morning-glory, and the seed of the two plants have a similar appearance. Rootstock grown from seed at the Station is sold directly to Mississippi producers, ensuring a reliable supply that is well adapted to conditions in the State.

Personnel at the Station put a lot of quality control into their foundation-seed work. "Seed roots are selected for productivity, shape, size, internal and external color, and freedom from disease and insect damage," says Research Assistant Bill Burdine.

He adds that each individual root that is placed in beds to produce plants for the foundation-seed program is sliced open to look at the flesh color and to make sure the root is disease free.

"We would not have a reliable source of foundation seed if we didn't have the work here at Pontotoc," explains Randle Wright, a Calhoun County sweetpotato producer and president of the Mississippi Sweetpotato Council. "The breeding work at the Station also is important for producers in this area."

Field studies of the MAFES sweetpotato breeding program were moved from the MSU campus to Pontotoc in 1993. The move has provided several benefits, including the availability of soil types that are similar to those in the sweetpotato-growing areas of the State.

"Most sweetpotatoes in north Mississippi are grown in the silt loam soils found in the flatwoods section of the State," says MAFES Horticulturist and Sweetpotato Breeder Paul Thompson. "Breeding lines developed at the Station are produced in those soil types. The growth of sweetpotato roots is affected by soil type, so the plants that grow well at Pontotoc should grow well in the major production areas of the State."

Thompson adds that the goal of the research program at the Station is to release sweetpotato varieties that are ideally adapted to Mississippi conditions and that are resistant to damage from the diseases and insects found in the State. The disease-

resistance work for the breeding program is conducted by MAFES Nematologist Gary Lawrence.

Selections from other breeding programs also are planted at Pontotoc as part of the national Sweetpotato Collaborators variety trial. In addition to the promising advanced breeding-line selections from Mississippi, selections from Louisiana, North Carolina, and South Carolina are being evaluated at the Station.

`Beauregard' is the most popular sweetpotato variety in Mississippi. The variety is planted on more than 95 percent of the State's acreage, and most of the foundation seed grown at Pontotoc are for the Beauregard variety.

Thompson and Research Assistant Jeff Main initiated a plant-bed fertility research project in 1994 to determine the optimum rates of nitrogen, phosphorus, and potassium for the Beauregard variety.

"We have not gotten a yield increase or an increase in plant survival using several different rates of commercial fertilizer," says Thompson. "The results of field trials at the Station the past three seasons indicate producers can get maximum yields using lower than currently recommended rates of commercial fertilizer."

Another project underway at the Station is an evaluation of greenhouse- produced sweetpotato seedlings to see if they are comparable to those produced in the field.

"If the study shows greenhouse plants are equal to those produced in the field, we can go from producing 12,000 seedlings a year to about three times that number," Main says.

Part of the sweetpotato research at the Station has gone high-tech with the addition of a global positioning system/geographical information system (GPS/GIS) project this year. The research is under the direction of MAFES Agronomist Jeff White, who is using the technology to get a detailed soil- sample analysis of a 16-acre field used for foundation sweetpotato production at the Station.

"The sweetpotato is a notoriously variable crop," White says. "Growers talk about fields or areas within fields that consistently produce better yields and higher quality sweetpotatoes than adjacent fields or areas."

The agronomist adds that the differences in production by seemingly consistent soil may be the result of underlying soil differences.

With the GPS/GIS technology, which uses satellite data to pinpoint locations on the ground, White has produced a map that divides the 16-acre field into quarter-acre grids. Using the grid map and intensive soil sampling, he will identify and correct nutrient needs and other factors to improve yields and quality throughout the field.

"We're using the GPS/GIS system to find ways to identify nutrient needs and other factors that producers can manage to produce better yields," he says. "We will soon circulate a survey among producers to locate fields that have areas producing significantly better yields and quality than the rest of the same field. The GPS/GIS system can then be used to pinpoint those areas and analyze their characteristics."

Other sweetpotato research underway at Pontotoc includes pesticide evaluations, an experiment to measure the effect of different topsoil thicknesses on sweetpotato production, and evaluation of the use of sweetpotatoes in crop rotation with cotton, corn, and soybeans.

The work at the Station and the commitment of Mississippi's producers to supplying a quality product has helped the State become a supplier of sweetpotatoes to wholesale groceries throughout the United States and Canada. In fact, the reputation of the State's product is so good, the Sweetpotato Council is working to get all crates of sweetpotatoes shipped to wholesalers labeled as a Mississippi product.

## Sweetpotato pie

1 stick margarine 2 c. cooked sweetpotatoes 2 c. sugar 3 eggs 1 small can evaporated milk 1 tsp. vanilla 1 1/4 tsp. cinnamon

Mix potatoes, sugar, and margarine well. Add other ingredients and mix well. Bake 1 hour at 350 degrees. Makes 2 pies.

Courtesy of Mississippi Sweetpotato Council

## Research keeps Mississippi in the "green"

What's big, green, and covers Mississippi? No, it's not kudzu. It's the State's "green industry," the commercial nurseries that supply shrubs, flowers, and other landscaping plants and materials to homeowners and businesses.

The green industry is a $500 million annual business in Mississippi. MAFES research in the area benefits both the industry and homeowners by evaluating plants and products for performance in the State.

MAFES scientists conduct research with ornamental plants and production methods at several locations, but ornamental horticulture is a primary focus of the South Mississippi Branch Experiment Station in Poplarville.

The South Mississippi Branch has long been known as a site for woody ornamental research, but projects added recently include work with roses, petunias, verbenas, and other types of flowers.

"At the Branch, we evaluate plant material ranging from herbaceous annuals and perennials to shrubs and trees for the Mississippi Medallion program, an Extension Service program used to educate the public about plant performance in the State," explains MAFES Horticulturist Patricia Knight. "The top-performing plants in the evaluations become Mississippi Medallion selections, and by choosing those plants for their landscapes, homeowners are assured of getting varieties that are well adapted to Mississippi conditions."

Knight is in charge of ornamental horticulture research at the Branch. She explains that there is a lot more to the work than just growing pretty flowers or green shrubs.

"Ornamental horticulture research at the Branch involves a comprehensive approach,"

she says. "Research projects are currently underway in the areas of weed control, fertilization, plant selection, and media components."

South Mississippi nurseries play an important role in the Branch's research by providing input about the needs of the industry and by providing a commercial setting for some of the research. One example is a herbicide evaluation project underway at GreenForest Nursery in Perkinston.

The work being done by Knight at GreenForest is part of a cooperative project with Auburn University and the University of Tennessee. One goal of the project is to obtain labeling of herbicides needed for the pot-in-pot system used by commercial nurseries. The pot-in-pot system uses a series of pots buried in the ground to hold plants being grown in the same size container. Use of the system avoids problems with heat buildup around the root zone of containerized plants and with plants tipping over on windy days. No herbicides are currently labeled for use with pot-in-pot production.

Another goal of the research is to develop a system for directed herbicide spray applications to replace the broadcast system now in use. Use of a directed spray has economic and environmental benefits, according to GreenForest owner Dan Batson.

"An effective directed-spray system will be less expensive for us because it puts the material where it is needed with less loss," he says. "It's also good for the environment because less of the spray lands outside the pot."

Also being studied at the Branch are alternative weed-control methods for use with large containers in nurseries.

"The value of the plants produced in large containers coupled with the problem of nontarget herbicide loss make the use of mulches an attractive alternative to herbicides for nurseries," Knight says.

At the Branch, work with mulch includes the use of kenaf chips, pellets made from recycled newspapers, and other alternatives to herbicides for weed control in containers. The mulch project is being conducted in cooperation with researchers at Auburn University. The researchers have found that several of the alternative methods of weed control work as well as herbicides.

Knight explains that no economic comparisons have been made, but she notes that some of the alternatives are providing longer weed control than the 3 months usually obtained from herbicides. Commercial manufacturers of garden and landscape products also cooperate with some of the projects at the Branch.

"The Scotts Company and Pursell Industries are cooperating with a project to evaluate experimental and existing fertilizers for performance in south Mississippi," Knight says. "This collaborative effort serves the industry by ensuring that commercial growers in the area will have fertilizers that provide the nutrients needed in their particular situations."

Another area of ornamental horticulture research at the Branch involves work with some nontraditional potting media to find new types that are cost effective and readily available.

"Sphagnum peat moss is commonly used as a potting-medium component," Knight says.

"The cost and availability of this product is subject to weather conditions during the harvest season in Canada."

She adds that a more reliable alternative to sphagnum peat moss may be coconut coir pith, a by- product in the coconut industry. Research at the Station shows coir pith provides excellent water-holding capacity. Several additional evaluations of the product are underway on azaleas and other crops that use peat moss as a media component.

"In an experiment with annuals, coir-based media resulted in foliar color ratings, pH and electrical conductivity, shoot dry masses, and root ratings that were equal to or better than peat moss with most varieties," Knight says. "Exceptions were the shoot dry masses of impatiens and petunias and root ratings of melampodium."

The MAFES research has shown that irrigation modifications may be needed when coir is substituted for peat moss. Knight explains that changes in irrigation practices may alleviate the growth difference seen during the comparison of the two materials.

"All of our research is aimed toward helping Mississippi's horticulture industry," Knight explains. "The industry is very supportive in providing time, plant material, space, and anything else needed to make our research with ornamental plants a success."

One indication of the success of the ornamental horticulture work at the Branch is its selection for participation in the National Arboretum's plant evaluation and release program. Horticulturists at the Branch have evaluated cold-hardy, disease-resistant crape myrtles for the program since 1985. "We are currently evaluating dwarf crape myrtles, cherries, and redbuds for the National Arboretum," Knight says.

Such evaluations are important in helping nurseries provide their customers with plants that will perform well.

"Just because a plant is popular with homeowners doesn't mean it will do well in the heat of south Mississippi," Batson notes.

He adds that the research at Poplarville is on the leading edge of what's going on in an industry that's changing at a quick pace.

"The work we do at the Branch is made possible by the strong support we receive from the commercial nurseries in south Mississippi," Knight says. "They're helping make this area a leader in the industry."

## Turfgrass industry thriving in State

The product is often trampled and is always underfoot, but that's because the turfgrass industry is alive and thriving in Mississippi.

The turfgrass industry has a significant impact on Mississippi's economy, with annual gross sales of about $375 million.

Mississippi's turfgrass industry employs almost 6,000 full-time and nearly 14,000 part-time workers. Maintenance of the turfgrass costs more than $353 million in materials and labor.

"As a commodity, turfgrass is not a large industry, but as a service industry, it is very important in the State," says MAFES Weed Scientist Euel Coats. "You basically only establish turfgrass one time, and the rest is service and maintenance."

The turfgrass industry encompasses turfgrass producers, producers of turfgrass products, service firms, wholesalers and retailers, and consumers of turfgrass and related products.

John Cobb and his wife, Nell, own Mississippi Grass Nursery in Hattiesburg. They attended a July 22 Turfgrass Field Day at the Plant Science Research Center. The annual event is an opportunity for turfgrass industry representatives, golf-course managers, and others to see the results of MSU turfgrass research.

"I use the research done by Mississippi State because in a commercial business, we don't have the time or the facilities to do our own research," Cobb says.

The Cobbs' business was started about 25 years ago with help from MSU. Today, they still turn to the University for information and research on the turfgrass industry.

Turfgrass grown by Mississippi producers can be found at residences, golf courses, churches, parks, cemeteries, roads, airports, and other locations. There are 3,504 acres in the State in commercial sod production.

Extension Horticulturist David Nagel says sod producers harvest about 4,000 square yards per acre. The approximate prices received by sod farmers include Bermudagrass for $1 a square yard, centipede for $1.25, St. Augustine for $1.50, and zoysia for $2 a square yard.

MSU has about 12 acres of turfgrass test plots. Researchers test all aspects of turfgrass, including weed-control methods, soils and soil amendments, fertility, and plant-growth regulators.

Based on research results, evaluations and guidelines are set for use in the industry. The University also sponsors field days and short courses as part of its support of the industry.

Lyle Blausey, a formulator with The Andersons Processing Group in Maumee, OH, was on campus for the Turfgrass Field Day. Blausey's firm puts herbicides in a form most easily used for certain treatments.

"We seek the University's expertise on turfgrass as we try to find the methods that work best for us," Blausey says.

MAFES Agronomist Mike Goatley says with 110 students, MSU is 1 of the 3 largest of the Nation's 25-30 universities offering a 4-year degree in turfgrass management. The degree is a bachelor of science in plant and soil sciences with an emphasis in golf- and sports-turf management.

"A unique feature of the turf-management program is the mandatory cooperative-education requirement," Goatley says. "We require all our students to get three semesters of on-the-job work experience."

The turf-management program complements the professional golf-management degree

offered in the MSU College of Business.

## Seed program meets industry needs

The Seed Science and Technology Program at Mississippi State University is anything but "seedy." The Program has achieved national and international recognition for its research, teaching, and outreach activities.

The Program was recently reorganized to provide the research and teaching expertise needed to meet demand for additional work in the areas of molecular genetics, biotechnology, tissue culture, and seed treatments.

"Through the Program, all the elements of the seed industry have been brought together on the MSU campus," explains Richard Mullenax, head of the Department of Plant and Soil Sciences. "All of those elements, from top scientists and educators in an array of seed-related disciplines to up-to-date research facilities, are available to address the challenges facing the seed industry."

Because of Mississippi's climate and importance in the production of cotton, soybeans, rice, and other major row crops, many of the Nation's leading seed companies have facilities in the State. Mississippi is home base for some of those companies.

The research, outreach, and education aspects of the Seed Science and Technology Program provide highly trained personnel, technical support, and continuing education services for the seed industry. Through the Program, scientists conduct basic and demand-driven research related to problems in the seed and plant industries.

An important part of the seed-related research at Mississippi State focuses on seed as a carrier of technology. MAFES researchers and other scientists at the University played important roles in the development of worm-resistant, Bt cotton. Approximately 30 percent of the cotton planted in the United States during the 1997 season was Bt cotton.

Current seed-related research projects include efforts to develop corn with resistance to fall armyworms and introduction of Roundupr herbicide resistance into commercial rice varieties.

Outreach activities conducted through the Program provide opportunities for seed industry personnel receiving up-to-date training in various aspects of their industry. The annual Seedsmen's Short Course is one of the Program's outreach activities.

"Training Mississippi State students for careers in the seed industry is another important role of the Program," Mullenax says. "A student may take seed science and technology courses leading to a B.S., an M.S., or a Ph.D. degree in agronomy through the Department of Plant and Soil Sciences."

Internships are an additional part of the Program. Opportunities exist for Mississippi State students to work in industry settings and for industry personnel to train at the campus facility.

The scientists associated with the Program teach and conduct research in classrooms and laboratories at several locations on the MSU campus. Most of the work associated

with the Program, however, takes place in a multibuilding complex used for research, teaching, and other activities that support the seed industry. The complex houses the State Seed Testing Laboratory, the Mississippi Seed Improvement Association, Variety Evaluations and Foundation Seed Stocks, and research support units.

The heart of the complex is the Noble Pace Seed Technology Building. A full-scale seed conditioning plant is in the facility, and a teaching lab is configured to create distinct conditioning lines for many types of seed. Noble Pace also houses equipment loaned to the University for evaluation, research, and teaching. Approximately 20 companies currently have equipment in the facility.

One of the latest additions to the equipment available to the Program is a cut-down extractor-feeder gin stand and a cut-down lint cleaner donated by the Continental Eagle Corp. This piece of equipment is fully operational and has been fitted with a Plexiglasr side to allow observation of foreign-matter extraction and fiber/seed separation processes.

The primary use of the gin equipment is to train students enrolled in the Gin Management and Technology (GMT) option offered as part of the Department of Agricultural and Biological Engineering's Agricultural Engineering Technology and Business degree program.

"This equipment allows students to see the major aspects of cotton ginning and to conduct basic laboratory exercises," says Jerome Gilbert, head of the Department of Agricultural and Biological Engineering. "In addition, MAFES scientists and other researchers will use the equipment as part of cotton research projects. It also will be used in the GMT course for gin personnel that is offered in conjunction with the USDA Cotton Ginning Research Unit in Stoneville."

The constant addition of state-of-the-art equipment and the emphasis on new technology are helping the Program assist Mississippi's seed businesses to meet the challenges facing their industry.

"A reliable supply of high-quality seed is a basic necessity for agriculture," Mullenax says. "The Seed Science and Technology Program at Mississippi State is designed to provide seed companies with the support they need to keep producers of major row crops supplied with top-quality seed."

## Effects of incubational environment and breeder hen age on yolk utilization and embryo body

David Peebles

A common problem in the poultry industry throughout Mississippi is lowered hatch percentages of eggs from young or immature hens. The low hatch rate also is associated with early embryo mortality and subsequent poor chick performance after hatch. Alterations in incubational environment, such as changes in relative humidity, have been shown to influence embryo development in chicken eggs. The precise changes necessary to promote the hatching process in eggs from young hens are not known.

To respond to this problem, the U.S. Poultry and Egg Association is funding a 2-year research project in the Department of Poultry Science at Mississippi State. The goal of the project is to obtain a better understanding of the influence breeder hen age and incubational humidity have on the use of the egg yolk by broiler embryos. The research also is examining the subsequent effects of those factors on the body composition of broiler chicks.

The project is in its second year, and preliminary results show that the age of breeder hens is the primary factor influencing yolk use by embryos. Two indicators of the use of yolks by embryos is the amount of yolk left in the egg after hatching and the fatty acid content of the yolk at certain times during incubation.

Embryos from young hens (26 weeks of age) are less efficient in their use of yolk. Also, yolks from the eggs of those hens exhibit unusual levels of certain fatty acids late in incubation. The presence of those fatty acids leads to depression of embryo fat and moisture content.

In addition, eggs from young breeders commonly experience a greater resistance to gaseous exchange and water loss across their eggshells because of thicker eggshells and egg whites than found in eggs from older hens.

Once completed, the study results will provide poultry scientists with the information necessary to modify humidity more precisely during incubation to correspond with breeder hen age. Precise decreases in incubation humidity will be necessary to overcome the natural resistance of breeder eggs to water loss without causing excessive losses in embryonic moisture content.

Even slight improvements in hatchability and post-hatch chick performance after making the correct adjustments during incubation in an industrial setting could result in significant savings to Mississippi's broiler producers.

## Soybean yield increases in Mississippi with rice rotation

Mark E. Kurtz, Charles E. Snipes, Joe E. Street, and Fred T. Cooke, Jr.

A field experiment was conducted over 8 years, 1983-90, at the Delta Branch Experiment Station on a Sharkey clay (very fine, montmorillonitic, nonacid, thermic, Vertic Haplaquepts) to evaluate the influence of various rice-soybean rotational patterns on soybean yields in subsequent years.

Seven crop sequences were chosen to evaluate the utility of rice for improving soybean yields. The seven treatments were continuous rice; continuous soybeans; 1 year rice, 1 year soybeans (1:1); 2 years rice, 1 year soybeans (2:1); 3 years rice, 1 year soybeans (3:1); 1 year rice, 2 years soybeans (1:2); 2 years rice, 2 years soybeans (2:2).

During the 8 years of this experiment, soybeans occurred 17 times in the various rotations following rice. Eight of these occurrences resulted in significant soybean yield increases over the continuous soybean system. When grown in the 1:1 system, soybean yields increased two of the four times this rotation occurred (7.3 bu/acre in 1986; 7.2 bu/acre in 1988). In the 2:1 (9.8 bu/acre average increase) and 3:1 (11.9 bu/acre average increase) systems, soybean yields were always significantly higher than the control. No

yield increases were measured for soybeans in the 1:2 rotation. Soybean yield increases occurred two of four times in the 2:2 system (11.1 bu/acre in 1985; 11.7 bu/acre in 1990). No pattern of continuous soybean yield increases was noted in the 8 years of the experiment .

Rice yields also benefited from these rotations. After year one, rice occurred 18 times in various soybean rotations, with rotational rice yields increased over the continuous rice system in 8 of those occurrences. After year one, when rice was grown in all plots except the continuous soybeans, rice yields increased in the 1:1 rotation two of the three times this rotation occurred (20.4 bu/acre in 1985; 42.4 bu/acre in 1987), one of five in the 2:1 system (29.6 bu/acre in 1986), one of five in the 3:1 system (43.4 bu/acre in 1987), one of two in the 1:2 rotation (46.1 bu/acre in 1986), and two of three in the 2:2 system (56.7 bu/acre in 1987; 46.3 bu/acre in 1988). Rice yields decreased after the third year of continuous rice and never yielded as high as in the first year .

When dollar values accumulated over the entire 8 years of the experiment and production costs were considered, all rotations out-performed continuous rice and continuous soybeans. During the last 4 years of the experiment, all rotational sequences and continuous soybeans provided higher net returns than continuous rice; however, only the 2:2 (rice/soybeans), 1:1, and continuous soybeans resulted in increased net returns compared to the 8-year average. The 2:2, 1:1, and 3:1 rotations provided significantly higher net returns than continuous soybeans. The 2:2, 1:1, and 3:1 rotational systems resulted in the highest net returns of $93, $74, and $52/acre/year, respectively, above specified costs during the last 4 years. The net return from the 2:2 system was significantly greater than that from the 3:1 system.

Average yields of soybeans from the rotations exceeded those from the continuous soybean system by 9.3 bu/acre (27.7 versus 18.4 bu/acre). Average net returns for soybeans following 1 or 2 years of rice were $65.30/acre, whereas average net return to continuous soybeans was only $8.29/acre.

The percent of organic matter was not increased by any system. Failure of rice straw to increase organic matter substantially supports earlier findings. Soil pH increased in every system in which rice was grown after the fourth year when compared to the continuous soybean system. Before the fifth year of production, a trend for pH increase was started, and 57 percent of the treatments had higher pH values than the continuous soybean system. Urea, an acid-forming fertilizer, was applied at 260 lb/acre in 1983 through 1986 and at 326 lb/acre thereafter. Mississippi Delta water is very high in calcium carbonate and, thus, acts as a liming agent, driving soil pH higher. It is recommended in Mississippi to use ammonium sulfate when soil pH rises because it is the most acid-forming source of fertilizer available for rice production and will help bring down soil pH. Pettiet Agricultural Services estimates that 30 acre-inches of well water supply between 1 and 1.2 tons of lime-equivalent to the soil. Earlier reports indicated that pH reductions were related to plots where the greatest amount of N fertilizer was applied; however, the increase in pH values shown in these results seem to have resulted from repeated irrigation with water high in calcium carbonate.

The exchangeable calcium ($Ca^{2+}$) content of the soil fluctuated with time in this experiment. In most years, no differences in $Ca^{2+}$ occurred. Continuous rice had higher $Ca^{2+}$ in only 1 year when compared to continuous soybeans. Sharkey clay has a high

cation exchange capacity (40 meq/100 g), with relatively high calcium levels. The reported $Ca^{2+}$ does not reflect the total calcium found in the soil as free calcium and because of such a high $Ca^{2+}$ content, shift s are hard to detect. Year-to-year increases in exchangeable $Mg^{2+}$ occurred regardless of cropping sequence. In the last 3 years of the experiment, $K^{+}$ levels were higher in continuous soybeans than in continuous rice. One explanation for the elevated P content in soils in 1989 and 1990 was that there was a solubilization of Fe-reducing P compounds, thus causing an increase in soil-test P in the continuous rice plots in the last 4 years compared to continuous soybeans. Zinc levels fluctuated from year-to-year, with no apparent pattern evident for the various cropping systems.

In summary, when soybeans were grown behind 1 or 2 years of rice, the average soybean yield increased 9.3 bu/acre compared to continuous soybeans, resulting in a $57.01 increased net return. The rotations resulting in the highest returns above specified costs during the last 4 years were the 2:2 and 1:1 rotation with a 3:1 being equal to the 1:1. Each of these rotational systems returned a higher dollar value than either continuous soybeans or continuous rice. These data clearly indicate that rice makes a valuable rotational crop with soybeans and that the returns far exceed those for either crop grown in continuous monoculture.

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