MAFES Research Highlights

Summer 1997

Contents

Director's Letter:

Agriculture has changed dramatically since the Mississippi Agricultural Experiment Station was established at Mississippi Agricultural and Mechanical College 109 years ago. Just as tractors and mechanical harvesters have replaced animal and hand labor as the primary sources of power on today's farms, computers and other electronic forms of communications have revolutionized information delivery to the farm home or office.

The work of the Experiment Station has changed to meet the needs of today's agriculture, but the basic philosophy remains the same: meeting the food and fiber needs of society through sound science that provides good stewardship of the natural resources entrusted to us.

Today, research programs of the Mississippi Agricultural and Forestry Experiment Station (MAFES) are conducted through four regional research and extension centers located at Biloxi, Raymond, Stoneville, and Verona, in addition to the campus of Mississippi State University. The location of branch stations throughout the State allows MAFES scientists to conduct research under conditions that match those on the farm. Research plots on the farms of cooperating producers also help ensure that research is meeting the actual needs of Mississippi agriculture.

Demands for farm products continue to grow, but they are being met by fewer farmers, less and less labor devoted to agriculture, and more restrictions on chemical use and other inputs. With this situation in mind, MAFES scientists are using new technology, innovation, and dedication to agriculture to help farmers meet the demand for their products.

The Mississippi Legislature has always been keenly aware of the importance of agriculture to the State, and its members have worked to keep funding stable at the State level. Findings from some of the special research initiatives funded by the Legislature in recent years are featured in this issue of Highlights. The support we receive from private companies, commodity organizations, agencies and organizations, and individuals also helps provide research projects that meet the specific needs of Mississippi agriculture.

New technology is opening up possibilities that were undreamed of just a few years ago. Computerized management systems, an array of new agricultural chemicals, genetically engineered plants that produce their own resistance to insect and weed pests, and the concept of precision farming using remote sensing and satellites are just a few of the tools that are now available for use on the farm.

Learning to use these tools can be an expensive process for a farmer, however, if he has to depend on a trial-and- error approach to adapting them to his particular situation. Research directed at helping producers adapt new technology and products to fit the needs of Mississippi's farmers is an important part of the work of MAFES.

Producer advisory committees are another important part of the research process. Direct communication from producers helps researchers respond faster and in ways that are specific to local needs. The producers who serve on cotton, soybean, dairy, beef, fruit, and a host of other advisory committees around the State are able to tell their specific needs to MAFES scientists.

Changes in farm legislation at the Federal level present great challenges to agricultural research. As these challenges arise, they are met with new and more effective ways of accomplishing research goals.

I am confident that MAFES research programs will continue to provide support for our farmers as they work to meet the challenges of providing society's needs.

Vance Watson

Adaptive biotechnology

Biotechnology refers to the use of living organisms or their products to improve human health or the environment.

Examples of biotechnology in agriculture include the development of disease- or insect-resistant plants, such as Bt cotton, and the use of growth hormones in cattle.

The goals of biotechnology research are to increase production and reduce chemical usage, thereby decreasing production costs and increasing profits.

Cloning and expression of a 33 kD cysteine proteinase correlated with fall armyworm resistance in maize

Dawn Luthe

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Objectives:
        Researchers are investigating why some of the inbred corn lines developed through the
USDA/ARS breeding program at
MSU have resistance to the fall armyworm.
        Scientists are working to isolate and sequence the gene for the 33 kD cysteine proteinase, an
enzyme present in resistant
corn lines.
        They hope to express the gene for the 33 kD proteinase in bacterial cells.
        The researchers will conduct insect feeding bioassays using the 33 kD cysteine proteinase isolated
from bacterial cells.
        An additional goal of the research is transformation of plant cells with the gene for the 33 kD
cysteine protein-ase.
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Results: A gene called mir1 (maize insect resistance 1) was isolated from the corn inbred MP708, which is resistant to fall armyworm feeding. Sequence analysis of mir1 indicates that it encodes a 33 kD cysteine proteinase that is associated with fall armyworm resistance. A specific region of the mir1 gene has no homology with other known cysteine proteinases, suggesting that it is a unique protein.

A region of the mir1 gene was placed in the bacteria E. coli. The bacteria use the mir1 gene to make large amounts of 33 kD proteinase. The 33 kD proteinase produced by the bacteria is identical to that made in corn callus, but it has less activity than the naturally occurring enzyme.

Antibodies specific to the 33 kD cysteine proteinase have been developed. They are being used to detect the presence and amount of the 33 kD protein in plant tissues.

The greatest difficulty in this project has been developing a reliable larval feeding bioassay. Fall armyworm larvae have been reared on various diets containing the 33 kD proteinase isolated from bacteria. Most of these studies have been inconclusive. Work is continuing with the bioassays.

It is possible that the mir1 gene must be present and expressed within plant cells to inhibit larval growth effectively. Black Mexican Sweetcorn (BMS) suspension culture cells have been transformed with the mir1 gene. These cells produce an enzyme that is identical to the 33 kD proteinase and has enzymatic activity. When sufficient quantities of BMS cells expressing the protein are available, they will be used in larval feeding bioassays.

It is possible mir1 could be used in addition to Bt to protect plants from insect damage.

Modification of catfish muscle using a cytoplasmic vector John Boyle, Bob Wilson, and Larry Hanson

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Objectives:
        Scientists working with the project hope to standardize methods of insertion of foreign DNA into
fish eggs and embryos.
        An additional goal is modification of catfish muscle development by using a cytoplasmic vector
carrying the ski gene, a
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gene that regulates early muscle development.

Results: Initial progress has been made toward developing a Zebra fish model for modification of fish embryos.

Vectors producing a fluorescent protein have been designed for use in fish. Identification of antigen encoding genes from edwardsiella ictaluri that induce protective immunity to enteric septicemia of catfish (ESC) Larry Hanson and Jerald Ainsworth

Objectives:
Infectious diseases cause major losses in the catfish industry. To improve production efficiency, it is essential that practical, effective vaccines be developed. This study focuses on the development of an effective vaccine against enteric septicemia of catfish (ESC), the most important infectious disease in the catfish industry.
One goal of the study is to develop a method to identify genes of disease-causing bacteria that code for proteins that are important for vaccine function.
Scientists working with the project hope to identify genes of Edwardsiella ictaluri, the cause of ESC, that will provide protection from ESC when expressed from DNA injected into the muscle of catfish.
An additional objective of the project is to clone the genes that provide protection against ESC into a form of the virus that has reduced ability to cause disease and can be used as a vaccine agent.

Results: Researchers have modified a commercially available fragment of extrachromosomal (plasmid) DNA that allows the isolation of genes that code for proteins of a bacterium recognized by the immune system of animals.

The research has demonstrated that catfish can develop an immune response to genes expressed from DNA injected into muscle.

The scientists working on the project have demonstrated the effectiveness of recombinant channel catfish virus in inducing an immune response to the products of bacterial genes when inserted into the channel catfish virus genome. This development will allow the identification of protective genes for ESC and express them from an effective vaccine vehicle.

Increasing fertility in swine by examining proteins influenced by exogenous insulin Nancy Cox and John Boyle

Objectives:
A primary objective is to improve the efficiency of swine production by increasing litter size.
The researchers are seeking to identify proteins that function in the dynamic environment of ova production by the ovary. Once the proteins are identified, the researchers can isolate the genes.
The scientists hope to identify and explore compounds other than insulin that might increase litter size.

Results: Insulin has been shown to slow the growth of ovarian follicles. Eggs are contained in the follicles, and it's possible the slowed growth keeps eggs healthy longer.

In the study, insulin has lowered one protein responsible for ovarian function: insulin-like growth factor-1 (IGF-1).

The slowed growth probably allows more follicles to respond to the signal for ovulation. Identification and isolation of root-knot nematode resistance genes from corn. Nancy Reichert

Objectives:
Root-knot nematodes are a significant problem for Mississippi corn producers. Corn inbred lines with nematode resistance have been developed by USDA Research Geneticists W. Paul Williams and Gary L. Windham at MSU. One of those lines is currently being used in research to isolate "resistance" genes. Once isolated, they can be introduced into corn or any other susceptible plant species using genetic-engineering protocols.
Researchers are seeking to determine when resistance genes are induced after infection with root-knot nematodes using a resistant inbred corn line.
They hope to isolate and characterize genes from inbred resistant corn lines that are implicated in the observed resistance response.
The next step will be to test resistance genes in tobacco and eventually introduce them into corn for transgenic plant analyses.
The ultimate goal is development of gene transfer and regeneration protocols for corn.

Results: When compared to susceptible corn roots, resistant corn roots produced the greatest amount of unique proteins 9 days after

infection with nematode eggs. Some of those identified proteins might be induced as a result of the infection and may be involved in the resistance response.

A molecular method was developed that allowed the reliable isolation of complete gene sequences. This method is applicable to all species.

A unique gene was isolated from root-knot nematode-resistant corn, which may be implicated in its noted resistance response. The gene has been identified in various other plant species in response to pathogenic infection, primarily against fungal pathogens. It has been implicated in what is termed a "hypersensitive" response in which plant cells essentially kill themselves after pathogenic invasion, which prevents the pathogen from feeding. This type of response could be one line of defense against root-knot nematodes.

To pursue further whether a hypersensitive response may be associated with root-knot nematode resistance in corn, gene regulatory sequences were isolated from another gene implicated in this type of response. Those sequences were isolated from corn and are currently being analyzed in transgenic tobacco plants.

Efficient corn transformation, or DNA delivery, protocols were developed for 21 corn lines, which included grain hybrids, a sweetcorn hybrid, and inbred lines using a piece of equipment commonly called a "gene gun." This device works similarly to a scatter gun, but helium gas rather than gun powder is used as the propelling force. Efficient corn regeneration protocols also were developed. The coupling of those protocols should enable the production of genetically engineered corn plants.

Catfish vaccine research targets #1 disease

Maintaining the health of their animals is important to all livestock producers. For cattlemen and most other livestock producers, a good herd-health program includes vaccinations against common illnesses. The same is true of catfish producers, but they face some obstacles to effective vaccination programs.

One problem faced by catfish producers is the absence of an effective way to protect their fish from Enteric Septicemia of Catfish (ESC). Recent figures compiled by the U.S. Department of Agriculture's National Animal Health Monitoring System show 78 percent of catfish farms experienced losses to ESC in 1996.

Industry estimates indicate that ESC has been the most important disease on 70 percent of catfish farms during the past 3 years, with economic losses estimated at between 2 and 6 percent of the farm-gate value of the nation's catfish crop each year. The farm-gate value of the catfish produced in the United States is about $300 million annually, with most production concentrated in Mississippi, Arkansas, Louisiana, and Alabama.

Losses to the disease are heaviest in the Delta because of the large concentration of catfish ponds in the region. Also, most Delta ponds are never completely emptied of fish. Once the disease is in a pond, it is passed from one batch of fish to another by the carryovers from the previous batch.

The National Warmwater Aquacul-ture Research Center (NWARC) at Stoneville and the College of Veterinary Medicine (CVM) at Mississippi State University are involved in developing and testing both live-attenuated vaccines and recombinant DNA vaccines against ESC. The research is funded with private support and through the Adaptive Biotech-nology Initiative.

"Vaccines are given to animals so they can develop an immune response to the proteins of disease-causing organisms," explains CVM Associate Professor Larry Hanson. "This allows the animal to recognize the disease agent as foreign and to eliminate it before it can cause disease."

Hanson is part of a research team working to develop a recombinant-DNA vaccine for use against ESC.

One problem in developing effective vaccines is identifying the proteins from the disease-causing organism that induces the most effective immune response. To combat the problem, Hanson and other CVM and MAFES researchers have developed a genetic tool that allows identification of genes that code for the proteins that would be most effective for vaccines.

"This procedure involves randomly cloning DNA fragments from a pathogen, in this case the bacterium Edwardsiella ictaluri, into an independently replicating genetic element, or plasmid, and identifying which fragments encode proteins that are recognized by immune animals," Hanson says. "This DNA is then injected into nonimmune animals to see if the protein expressed causes a good immune response that protects the animal from disease."

The researchers are using this tool to develop an effective vaccine for ESC. Once the genes are identified, they will be inserted into a virus that can carry these fragments of DNA into channel catfish.

The use of a virus to carry the vaccine is an important part of the research because developing a vaccine that is effective against ESC is only part of the challenge facing the MAFES and CVM scientists.

"For practical use in intensive culture systems, which are dependent on the production of high numbers of fish with relatively low individual value, vaccines must be inexpensive and adaptable to mass vaccination," explains David Wise, assistant fisheries biologist at the NWARC. "In the past, experimental injectable vaccines have been developed that provide protective immunity from ESC, but the vaccination procedures are labor intensive and economically prohibitive for use in channel catfish production systems."

Wise and other researchers at the Center are conducting experimental field testing of commercial live- attenuated vaccine.

The vaccination procedures involve immersing large numbers of juvenile channel catfish in solutions containing live bacteria that have been genetically modified to reduce virulence. The avirulent strains are capable of establishing short-lived, low- grade infections resulting in the development of acquired immunity.

The experimental trials have demonstrated that the vaccines significantly reduce mortality from ESC and appear to have practical application to the catfish industry.

The work being conducted with the recombinant-DNA vaccine is still in the laboratory stage, but Hanson hopes to conduct field trials within the next 2 years.

Enhanced cotton production systems

Cotton is the number-one cash-producing row crop in Mississippi. Research in support of this important industry is a major part of the work conducted by MAFES scientists. Projects covered by the special research initiatives are grouped into two categories: production and management systems for cotton producers in the hill areas and sustainable, cost-efficient strategies for managing cotton insects.

Cotton production and management systems for the hill section of Mississippi Joe Johnson, Normie Buehring, Roscoe Ivy, David Ingram, David Smith, David Laughlin, David Parvin, Stan Spurlock, William Batson, Gary Lawrence, Dan Reynolds, Teddy Wallace, and Jac Varco

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Objectives:
        Develop optimized agronomic and economically efficient production systems for cotton grown on
Brown Loam and
Prairie soils.
        Integrate new and existing weed control technologies into production systems of cotton grown on
Brown Loam and
Black Prairie soils.
        Determine the impact of changes in cultural practices such as tillage systems, crop-rotation
sequences, cover crop, row
spacing, plant population, and varieties on the severity of disease and the relative effectiveness of disease-
management
techniques and products.
        Develop nutrient-management strategies for alternative production practices in upland cotton.
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Results: Plant population data indicate that established stands ranging from 41,200 to 88,570 plants in 7.5-inch rows produce more seed cotton than the standard 30-inch rows.

The ground residue cover study shows continuous no-tillage and ridge-tillage cotton had more than 50 percent ground residue, whereas minimum tillage and conventional tillage had less than 10 percent ground residue after planting.

Four-year yield data show higher lint yield for both ridge-tillage and minimum-tillage cotton following ridge-till corn on Leeper silty clay soil than for ridge-tillage and minimum-tillage continuous cotton. An economic analysis for three cotton rotation systems shows cotton behind corn had the highest lint yields and net returns, cotton behind cotton had intermediate yields and returns, and cotton behind soybeans had the lowest lint yields and net returns.

Three-year average yields on clay soils indicate paratill bed systems produce higher yields than all other continuous cotton tillage systems. On silt loam soil, tillage had no effect on lint yield. There was a significant increase in seed cotton yields with vetch compared to native cover, but there was a significant decrease in yield in wheat and crimson clover compared to a native cover crop. The wheat cover crop had the highest net returns and vetch had the lowest net returns.

Evaluation of Roundup Readyr cotton in conventional and no-till planting on Prairie soils shows that it has the potential to economically control some of the difficult-to-control weeds in cotton. There is a need, however, for better agronomically adapted

varieties with higher yield potential than those evaluated at some locations for the technology to be sustainable.

Data from a 1996 study suggest that application of an in-furrow fungicide may be important in stand establishment of cotton in reduced-tillage planting systems where plant residues remain on the soil, even when conditions are favorable for emergence.

Development of sustainable, cost-efficient strategies for managing cotton insects Randy Luttrell, Aubrey Harris, and Jack Reed

Objectives:

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        Establish a coordinated program of evaluating cotton insect management options in replicated
field plots in the Delta and
hill regions of the state.
        Initiate an experimentally sound program of evaluating major changes to currently recommended
management strategies
in production fields.

        Revitalize efforts to develop decision tools and simulators necessary to introduce new cost-
effective management
options for cotton insects.
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Results: Planting-date evaluations of insecticides for control of thrips indicate late plantings made under optimum growing conditions may not benefit from in-furrow insecticide applications.

Small plot evaluations at the Delta Research and Extension Center established guidelines for producers to use in terminating insect-control applications with minimal risk of crop loss.

This project was the first by an independent research unit to evaluate commercialized Bt cotton. The results are providing growers, consultants, and others in the cotton industry with vital information on the new technology and have established MAFES as a prominent source of information on Bt cotton.

MAFES researchers involved with the project are revising Cotton Insect Consultant for Expert Management (CIC-EM), a computer-based management model for cotton producers. The revised CIC-EM will be based on the expertise of 3 leading cotton entomologists for controlling 13 cotton insect pests. It will contain insect control knowledge for both Bt cotton and non-Bt varieties.

Hill cotton producers face new challenges

The 1985 Farm Bill changed the way cotton is grown in the hill sections of Mississippi. The legislation required that all producers submit a conservation plan by 1990 to qualify for Federal crop programs. The plans had to address the problem of soil erosion in areas with highly erodible land, and they had to be implemented by 1995.

"Cotton produced with conventional tillage practices can result in significant erosion, especially in hill areas," explains MAFES Agronomist Joe Johnson at the North Mississippi Branch in Holly Springs.

"To comply with requirements of the 1985 Farm Bill, most farm plans in Mississippi's hill sections include the use of minimum-tillage practices and winter cover crops. Both of those practices call for the use of new management systems."

Research to support Mississippi's cotton producers has always been an important part of the work of MAFES scientists, but the implementation of the farm plans challenged them to coordinate research efforts in order to provide the necessary management systems. The funding provided by the special research initiative for enhanced cotton production systems provided the opportunity to coordinate those efforts.

The overall objective of the initiative is to develop production systems that will meet the need to limit soil erosion and pesticide runoff from fields while keeping cotton a profitable crop in the hill areas of the State.

One area of study supported by the initiative is the crop and tillage rotation work being conducted by Johnson; MAFES Agronomists Normie Buehring, David Ingram, and Roscoe Ivy; and Agricultural Economist Stan Spurlock.

The group is studying rotation systems that include cotton following corn or soybeans and continuous cotton with conventional- and minimum-tillage systems. Their work also includes research with cover crops, including native cover, vetch, crimson clover, and wheat.

The researchers have compiled 4 years of data indicating both conventional- and minimum-tillage cotton following conventional-till corn on a Leeper silty clay soil can produce greater lint yields than conventional-till and minimum-till continuous cotton.

An economic analysis for the three cotton rotation systems in 1996 shows cotton after corn had the greatest lint yields and net returns, continuous cotton had intermediate yields and returns, and cotton after soybeans had the lowest lint yields and net returns.

The cover-crop work by the group during 1996 showed a significant decrease in seed cotton yields with vetch compared to native cover, but no difference in yields in wheat and crimson clover compared to a native cover crop. The native cover had the highest net returns and vetch had the lowest.

The projects supported by the 1994 Special Legislative Initiative also are helping integrate new and existing weed-control technologies into hill cotton production systems, promoting development of nutrient-management strategies for alternative production practices, and allowing researchers to measure the impact of changes in cultural practices on the severity of cotton diseases.

Plant Pathologist Bill Batson is one of the MAFES researchers working to find ways to control disease problems in the reduced-tillage systems now in use in the hill areas.

"With minimum tillage, seeds are planted into seedbeds that are cooler than the raised seedbeds used in conventional tillage," Batson says. "Early in the season, the cooler seedbeds slow seed germination and seedling growth and also provide a more favorable habitat for fungal growth and development. The result is more seedling disease."

A project conducted by Batson and Research Assistant Jacobo Caceres during the 1996 growing season suggests that application of an in-furrow fungicide may be important in stand establishment of cotton in reduced-tillage systems where plant residues remain on the soil.

The use of reduced tillage also has caused changes in the way cotton producers are handling weed control. MAFES Weed Scientists David Shaw and Dan Reynolds are among the researchers helping producers find new methods to control weeds.

"Anytime you eliminate a tillage operation, you are basically eliminating a weed- control operation," says Shaw. "Fortunately, there is a lot of new technology available for weed control by cotton producers."

In 1996, the weed scientists conducted field studies to evaluate Roundup Readyr cotton varieties, which have been genetically engineered for resistance to Roundupr herbicide; BXN cotton, which is resistant to the herbicide Buctrilr; and Stapler, the first over-the-top broadleaf herbicide for use on cotton.

"All three of these products have strong advantages over what we were using before," Shaw says. "Before these were available, you had to rely on a postdirected spray rather than being able to go over the top for weed control in cotton."

He notes that with postdirected herbicides, the crop must be taller than the weeds. If it is not, you are basically behind on weed control and it is difficult to catch up.

"Evaluation of Roundup Ready and BXN cotton varieties show they have the potential to economically control some very difficult weeds," Shaw explains. "However, varieties with higher yield potential than some of those evaluated in the past will be needed for the technology to be sustainable."

New, higher yielding cotton cultivars containing genes for BXN or Roundup resistance were available for planting this season and are being evaluated by MAFES weed scientists.

The use of winter cover crops to reduce erosion is altering nutrient-management requirements for cotton producers in the hill areas. Development of nutrient-management strategies for alternative production practices in hill-area cotton is the objective of research being conducted by Agronomists Jac Varco and Joe Johnson.

"The use of winter cover crops, which include vetch and winter wheat, provides a new set of management requirements, one of which is the need to manage nutrients differently," Johnson says. "For example, cotton planted to land that was in soybeans the previous summer or that had vetch as a winter cover crop does not need as much nitrogen as fields planted to cotton following corn."

The study conducted by Johnson and Varco in 1996 found that where 0, 30, 60, 90, 120, and 150 pounds of nitrogen per acre were applied within 1 week of planting no-till cotton on silt loam soils, essentially no yield differences occurred at the rates of 0, 30, and 60 pounds per acre. The 90-pound nitrogen rate produced significantly higher yields than the 0, 30, and 60 pound-per-acre rate, with no further yield increase at rates greater than 90.

More than 20 MAFES scientists are working on projects dealing with the various aspects of developing new management systems for cotton production in the hill areas of the State. The support provided by the research initiative is helping them coordinate their efforts

to provide producers with timely and accurate information and technologies they can use to make management decisions in their farming operations.

Enhanced feedgrains

Since 1995, corn acreage in Mississippi has more than doubled, jumping from about 300,000 acres to more than 600,000 this year. The reasons for the dramatic increase in producer interest in corn include attractive prices and the new "Freedom To Farm" bill. Corn is a logical crop for feed-grain production in Mississippi. The State's expanding livestock industry normally demands two to six times more feed than is produced in the State. The local demand and the ability to harvest and deliver corn up to 2 months earlier than supplies from the Corn Belt often result in a substantial premium for Mississippi-grown corn. Also, growing corn in rotation with other major row crops produces significant agronomic advantages for all crops in the system. MAFES research has kept pace with the expansion of the State's corn acreage through the establishment of projects to evaluate new varieties, management practices, pest control, and other aspects of production. The research in the area of corn production is being supported by the enhanced feedgrains initiative.

Improving Mississippi corn production

Glover Triplett, Erick Larson, Normie Buehring, Roscoe Ivy, Joe Johnson, Billy Johnson, Larry Trevathan, Jack Reed, Henry Pitre, Lynn Reinschmiedt, Stan Spurlock, Seth Dabney, Richard Wesley, and Larry Heatherly

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Objectives:
        Research in the enhanced feedgrains area seeks to evaluate corn grain yield response to cultural
and management
practices. Those practices include use of stale seedbeds and no-tillage, raised seedbeds, varying planting
dates, crop
rotations, and hybrid maturity.
        Other projects evaluate weed control systems and the response of corn insect and disease
complexes to various
management systems.
        Also included in the initiative is an economic analysis of corn production systems.
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Results: In a planting-date study, corn planted in stale-seedbed systems produced adequate stands and high yields beginning about March 15 in north central Mississippi. Adequate stands were not achieved until April 1 for corn planted no- till into established sod in the Black Belt area of the State. Late planting (after April 15) reduced corn grain yield.

Recently developed early hybrids have been evaluated for both grain yield and moisture at several locations in the State. Results indicate August harvest of early hybrids may be possible without sacrificing grain yield. Typically, Mississippi growers may receive high market prices because of seasonal trends and premiums for early delivery when corn supplies are short. This has resulted in growers receiving prices as high as 50 percent above the U.S. harvest average.

Transgenic corn hybrids tolerant to imidazolinone herbicides have been evaluated for no-tillage planting into established sod. Results from these studies indicate good crop safety coupled with effective control of perennial grasses and broadleaf species. Further development of these systems will permit corn production on upland sites where soil erosion limits annual cropping.

Tillage, planting date, and insecticide treatment in corn were evaluated to determine the influence on corn insects. Six insect species that feed on corn plants were more frequent in corn planted after April 15, but increased numbers of beneficial insects also were present. Two pest species were more frequently found in conventionally tilled plots than in plots with reduced tillage. Insecticide treatments had little influence on incidence of any insect species in plots. Extensive sampling failed to show corn is a host or a refuge for plant bug (Lygus lineolaris), indicating corn probably does not contribute to high numbers of this insect in cotton fields in the hill section of Mississippi. Information from this study is being used to design management strategies for insects associated with corn production.

Rotation studies that use no-tillage and conventional-tillage systems for corn are in progress at several locations in the State. Yield trends to date indicate a beneficial effect from rotating corn with another crop, such as soybeans or cotton, but several rotation cycles must be evaluated before definite conclusions are drawn from these studies.

Early corn planting slows crop emergence because of low soil temperatures. Early planting also subjects seedlings to attack by various disease organisms. The seedling disease complex has been studied intensively for different tillage systems and for planting dates. Pathogenic organisms isolated from corn seedlings vary according to the tillage system used. Disease is not a factor, however, in causing reduced stands for either conventional or no-tillage systems.

Results from a nonirrigated 7-year crop production study involving corn, soybeans, cotton, and grain sorghum in the Brown Loam

area of the state have been summarized and subjected to economic analysis. Yields of all crops varied according to growing season rainfall, which ranged from 50 percent below normal to 50 percent above normal during the study. Corn provided the highest average return of all crops and also had the most stable yield and return pattern. With corn, there was no year in which production costs were not covered by crop value, whereas conventional cotton had a negative return of more than $100 an acre during one season. Grain sorghum had several years with negative returns, and the overall average was barely more than the break-even point. The only cropping system with returns equal to corn was wheat- soybean double crop, but that system had some seasons with negative returns because of wide variations in wheat yields.

Environmental quality

The efficient and wise management of natural resources is a priority in modern agricultural production. MAFES scientists are helping to conserve and enhance the environment by developing new management strategies for agriculture and other natural-resource industries.

MAFES researchers are conducting projects to protect and enhance soil, water, and air quality in agricultural operations; develop methods to manage complex ecosystems to maintain biodiversity of both plant and animal species; develop new biological, physical, and socioeconomic databases to assure balanced management decisions and policy options; and generate new knowledge needed to enhance the quality of soil, water, and air by recovering and using plant, animal, and industrial nutrients now lost as waste.

Mechanisms and control of herbicide loss in Mississippi Delta crop production systems David R. Shaw, William L. Kingery, Charles E. Snipes, and James R. Heitz

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Objectives:
        The study will determine concentrations of fluometuron and imazaquin in soils, sediments, and
natural waters in Yazoo-
Mississippi Basin cotton and soybean systems.
        An additional goal is to determine the impact of sustainable cotton and soybean production system
variables, such as
tillage, cover-crops, and buffer-strips, on persistence and off-site transport of fluometuron.
        The researchers will explore soil characteristics and relationships that affect imazaquin persistence
and bioavailability.
        Data from the study will be used to formulate recommendations for best management practices for
herbicide usage in
sustainable cotton-soybean production.
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Results: Filter strips of tall fescue as narrow as 1 foot wide reduced herbicide losses in runoff by as much as 80 percent.

A number of grass species were evaluated to determine their effectiveness in filtering herbicides from runoff. Giant reed, eastern gammagrass, big bluestem, Alamo switchgrass, and tall fescue all effectively reduced herbicide losses. Tall fescue was more effective than several of the other species, and this was primarily attributed to its greater thatch layer, which serves as an adsorbent.

Fluometuron adsorption substantially increased in the soil of an established filter strip compared to bare soil. This was primarily because of increased organic-matter content.

Metolachlor and cyanazine were monitored in surface waters in the Mississippi Delta. Detections were always well below health advisory levels.

Monitoring and interdiction of off-target agricultural chemical movement on water quality through socio-environmental visualization methodology Frank M. Howell

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Objectives:
        The primary objective of this project is to identify and acquire appropriate data sources for
assessment of agricultural
chemical use.
        The researcher also is building data sources into a consolidated spatial database compatible to the
systems used by
MAFES researchers.
        This will be an ongoing project that will continue developing and prototyping socio-
environmental visualization
methodology for identifying off-target movement of agricultural chemicals and the impact of that
movement on water
quality.
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Results: Databases dealing with soils, water quality, agricultural chemicals, and other agricultural topics have been identified, acquired, and processed.

The databases have been made available to MAFES scientists and other researchers.

A scientific study of agricultural chemical runoff will be completed and made available to academic, commercial, and public-sector clientele during 1997.

Movement of agricultural chemicals in cracking soils and impacts on ground and surface waters David Pettry

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Objectives:
        The research is aimed at determining the distribution and extent of cracking soils in Mississippi.
        It seeks to quantify physical, chemical, and morphological parameters of cracking soils.
        An additional goal is to quantify crack development and flow paths.
        Data collected will be used to determine movement and impact of agricultural chemicals in
cracking soils.
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Results: The study has determined that clayey, cracking soils comprise about 20 percent of the State's total acreage. These soils occur extensively in the Delta and Blackland Prairies, with less acreage in the Interior Flatwoods, Coastal Plain, and Loessial regions. The clayey, cracking soils are prime farmlands, and they are used intensively in agricultural row- crop production.

Research indicates the soils contain 30- to 90-percent clay and have a high capacity to retain and exchange plant nutrients.

Field research indicates soil crack formation and extension occur when evaporation exceeds precipitation and soil moisture levels range from 22 to 30 percent. In Mississippi, those conditions generally occur during a 7-month period from March through October. Cracks range from 1 to 3 inches wide and extend to depths of 36 inches and greater. Water infiltration in the cracks exceeds 10 inches per hour.

Tracer studies indicate rapid vertical and horizontal movement through cracks of water containing agricultural chemicals. Current studies are monitoring movement of several types of chemicals.

Low-till systems with reduced surface disturbance for cotton in the Mississippi Delta Gordon Tupper, Harold Hurst, Wayne Ebelhar, and Fred Cooke

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Objectives:
        Researchers at the Delta Branch are investigating new production systems using the low-till
parabolic subsoiler
developed at the Branch. They are seeking to provide cotton producers with the ability to achieve
minimum surface
disturbance while maintaining lint yields and improving economic returns.
        The research includes a comparison of  new production systems to a no-till system for cotton
production and to a
conventional tillage system that uses the low-till parabolic subsoiler.
        Agricultural economists working with the study are determining the costs and returns of the new
in-row-
        direction, limited-soil-disturbance, deep-tillage system.
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Results: Averaged over three growing seasons, from 1994 to 1996, surface applications of 100, 150, and 250 pounds of potassium per acre did not improve no-till lint yields over the check with no potassium or over the conventional check. With the low-till system, however, 150 pounds of potassium per acre applied as a deep band under the row increased yields when compared to the no-till and conventional-tillage checks.

Crop residue remaining on the surface after planting was 4.3 percent for the conventional system, 13.3 percent for the low- till system, and 26.8 percent for the no-till system. These data show significant residue remaining on the surface with the low-till system compared to the conventional system.

The study shows the reduced tillage system with deep-band placement of potassium may provide an alternative to conventional tillage on the sandy soils of the Mississippi Delta. Additional research is underway to combine potassium application with the low-till parabolic subsoiler. This one-pass operation could significantly reduce the preplant tillage costs associated with conventional tillage.

An economic analysis for each system is still underway.

Poultry-litter disposal focus of study

Mississippi has gained an international reputation as a poultry supplier, with recent major broiler sales to Russia and other overseas customers.

The State's reputation is well deserved, according to Wallace Morgan, head of MSU's Department of Poultry Science.

"Mississippi has been the number-five broiler-producing state for several years and is set to pass North Carolina to move into the number-four position during 1997," Morgan says.

Broiler houses can be found throughout the State, but just four counties account for 75 percent of the State's production. Those counties, Scott, Smith, Simpson, and Jones, all are located in south Mississippi.

The geographic concentration of a large portion of the industry has raised concerns about proper management of the poultry waste, or litter, produced by the broiler industry. That concern is the focus of a research project being conducted by a group of MSU scientists and supported by the 1994 Special Legislative Initiative.

MAFES Agronomist Billy Kingery is the principal investigator for the project, which is examining the impacts of poultry waste-management practices on soil and water quality in Mississippi.

"One broiler house can produce in excess of 100 tons of litter every 1 1/2 to 2 years, which is the normal clean-out period for a broiler house," explains Kingery. "The Mississippi broiler industry produces about one-half million tons of poultry litter each year."

The information about the amount of waste generated, distribution of production, and other data were collected during the initial phase of the project, which began in 1995. Samples of soil, sediments, and natural waters within intensive poultry-producing areas of the State also were taken during the first phase of the study.

The next step was taken in 1996, with development of a database showing how representative Mississippi soils are impacted by poultry-waste application. That part of the study was conducted on a 5-acre plot on the Gary Chamblee farm in Neshoba County. The study area is part of a pasture where poultry litter has been applied for more than 20 years.

"The majority of poultry litter produced in Mississippi is applied to pasture- land," Kingery says.

"People tend to think all the nutrients in the litter are used by the grass in the pasture, but it is a more complex situation." Poultry litter is an excellent fertilizer because of its nutrient content. MAFES Poultry Scientist Tim Chamblee is studying the levels of nitrogen, phosphorus, and other nutrients in poultry litter.

"A major goal of the project is to provide producers with information they can use to get the most benefits from poultry litter as fertilizer for crops and still remain environmentally friendly," explains Chamblee.

There is concern that continual application of poultry litter to an area over a number of years could cause increased levels of nutrients in nearby sources of ground and surface water.

The Neshoba County part of the study consisted of an intensive analysis of the soil in the 5-acre site, as well as a nearby forest area that has not had poultry- litter applications. The researchers also have analyzed ground and surface water supplies in the area.

"We have looked at the Neshoba County site in detail, including a space-and-time study to determine the movement of different elements in poultry litter," Kingery says.

Part of the analysis of soil from the site has been done with nuclear magnetic resonance (NMR) equipment by MSU Chem- ist Ricky Hicks. NMR is similar to the magnetic resonance imaging (MRI) procedures used in the medical field. Using NMR, scientists can identify and measure reactions of compounds in the soil.

MSU Biochemist Ken Willeford is studying the biochemical reactions that have taken place in soils containing poultry litter. MAFES Statistician Pat Gerard is developing a statistical model based on the project findings, and MAFES Agronomist Mike Cox is conducting a spatial analysis of the study site using global positioning systems and geographical information systems (GPS/GIS).

Extension Agronomist Larry Oldham is working with the project and will be conducting educational programs based on the findings.

An additional part of the study is a collaboration with Agricultural Engineer Keith McGregor at the USDA/ARS National Sedimentation Laboratory in Oxford on measurement of water and soil runoff from test plots.

Many of the aspects of the project involve state-of-the-art technology, and the work is getting widespread attention.

"Some of the work being done with this project, such as the NMR study, is the first of its kind in the world and has attracted the attention of European and other overseas researchers," Kingery explains.

"The special research initiative has made it possible to bring the scientists from different University departments and organizations

together to form a team that is addressing a specific need of one of Mississippi's most important agricultural enterprises."

The study will be completed in about 2 years, and the researchers expect their data will lead to methods Mississippi producers can use to manage poultry waste in ways to allow industry growth without harming the environment.

Support from other sources

Participation in research projects is not limited to scientists working in laboratories and test plots. Mississippi farmers also play important roles in MAFES research. Scientists conduct off-station research on farms of cooperating producers in virtually every area of the State.

Farmers also help research through their commodity groups. Funding from the Mississippi Soybean Promotion Board, the Mississippi Cotton Incorporated State Support Program, and the Mississippi Rice Promotion Board currently supports more than 40 MAFES projects. The funding is provided through producer checkoff programs.

The projects receiving commodity-group support range from working with advanced information systems to improve soybean production to developing insect-resistant cotton varieties for Mississippi.

The need for systems that will meet conservation compliance requirements and the need to stay abreast of changing disease- and insect-control methods are some of the reasons university research programs are vital, according to Jimmy Summers, chairman of the Mississippi Soybean Promotion Board.

"It all boils down to dollars and cents," he says. "Every new product or system doesn't work, and we need to know what will and will not work for us."

Producers representing the commodity groups are part of a scientific peer review process that determines which projects receive commodity-group funding.

Projects supported by the Mississippi Soybean Promotion Board:

Soybean Management by Application of Research and Technology (SMART).

Enhancement of Mississippi soybean variety trials through entry standardization.

Soybean rotation and tillage systems in drilled soybean for conservation compliance in the Black Belt Prairie.

Early soybean production systems for alleviating the soybean rut syndrome on flood-plain soils.

Soybean variety characteristics, population, and row spacing's influence on sicklepod control with different weed management systems in the Black Belt Prairie.

Advanced information systems for improved soybean production.

Identification of reniform nematode resistance to new soybean varieties.

Studies on soybean viruses: 1. Determination of varietal resistance to major soybean viruses in Mississippi; 2. Efficacy of trap crops and insecticides to control virus vectors; 3. Identification of viruses present in the Mississippi varietal trials.

Evaluation of private and public soybean varieties and breeding lines for resistance to stem canker, phytophthora root rot, frogeye leaf spot, aerial web blight, and other diseases present in the varietal trials.

Evaluation of seed and hopper-box treatments and foliar-applied fungicides on group IV and early-planted group V soybeans to improve seed quality, emergence, and yields.

Long-term control program for redvine in soybeans.

Weed management systems using Roundupr- or Libertyr-tolerant soybeans.

Development of gene transfer protocols for soybeans.

Use of accelerated breeding methods to speed variety development.

Development of soybean varieties with resistance to cercospora fungal pathogens.

An economic evaluation of the impact of selected multiple technologies on net income for rice-soybean farms.

Determination of profitability of soybean production practices in Mississippi.

Marketing alternatives, strategies, and market performance for Mississippi soybeans.

Assessment of precision farming technologies in soybean production.

Assessment of Roundup Readyr programs versus conventional programs with regard to efficacy, varietal performance, and economics.

Process flavoring from soybeans.

Use of soy lecithin to improve texture and yield of reduced- and low-fat and processed cheddar cheese.

Soybean technology transfer.

Projects supported by the Mississippi Rice Promotion Board:

Rice breeding project at Delta Research and Extension Center.

Evaluation of spatial variability of soils for rice production utilizing GPS/GIS technology.

Control of rice water weevil.

Winter rice breeding nursery in Puerto Rico.

Spatial measures of nutrients for correction of fertility problems in Mississippi precision rice farming.

Rice weed control.

Introduction of Roundup resistance into commercial rice for long-term weed control. Evaluation of new experimental rice fungicides for control of specific diseases under natural disease pressure.

Support for pathology research associate to screen additional breeding lines for resistance to rice diseases.

Supplement for rice foundation seed stocks program.

Projects supported by the Mississippi Cotton Incorporated State Support Program:

An entomological, physiological, and economic evaluation of Bt cottons and non-Bt cottons.

Mississippi Cotton Pest Monitoring Program.

Developing insect-resistant cottons for Mississippi.

Management systems for transgenic cotton in ultra-narrow rows.

Advanced spatial technology use in cotton production.

Application techniques, economic comparison, and cotton tolerance for newly developed over-the-top herbicides for use in cotton.

Cotton insect-control efficiency.
